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COSTS TO THE PETROLEUM INDUSTRY OF MAJOR NEW AND FUTURE FEDERAL GOVERNMENT ENVIRONMENTAL REQUIREMENTS

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Costs to the Petroleum Industry of Major New and Future Federal Government Environmental Requirements

Jody Perkins

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The contents of this paper are for the purposes of study and discussion of government legislative or regulatory proposals and do not necessarily represent the views of the American Petroleum Institute or any of its members.

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Preface

This paper examines new and potential environmental requirements on the petroleum industry and information on compliance costs. The discussions of known and expected environmental requirements are in summary form, and are not intended to be used as guidance for legal compliance. In addition, the cost estimates presented are those identified by a search of the existing literature; they should not be construed as necessarily representing the views of API or any of its members.

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Executive Summary

This paper examines major new and potential federal environmental requirements that could impose significant compliance costs on the U.S. petroleum industry in the 1990s. Every sector of the petroleum industry is affected by a variety of requirements aimed at controlling releases to air, water, and land. For example, the Clean Air Act Amendments of 1990 require refineries to produce lower emission fuels, and the Oil Pollution Act of 1990 requires double hulls on tankers. New effluent limitations may restrict the ways in which exploration and production operators manage their discharges to water, and some service station owners and operators will have to comply with requirements for refueling vapor recovery systems.

Most environmental requirements will affect the petroleum industry directly. A few (e.g., automotive fleet requirements that would lead to the use of alternative and replacement fuels) may have indirect effects.

Petroleum industry compliance costs have been estimated for many, but not all major new and potential environmental requirements. The cost estimates vary in quality. Some are based on a proposed rule or legislation that was later finalized after some modification. In addition, some cost estimates cover only one or two sectors of the petroleum industry, when in fact more sectors could be affected. This paper attempts to make costs comparable by presenting them as annualized estimates, but true comparability is limited.

The environmental requirements discussed in this paper are listed in the following tables. Table ES-1 summarizes the available cost estimates for new requirements and requirements proposed (or nearly proposed) by federal agencies. Table ES-2 summarizes cost estimates for several potential, highly-uncertain requirements. Table ES-3 lists additional requirements for which little or no cost information is available.

The petroleum industry currently spends more than $8 billion per year on environmental quality and protection. Using a statistical simulation technique and the available cost estimates from Table ES-1 (but excluding the highly uncertain cost estimates for the requirements listed in Tables ES-2 and ES-3), it is estimated that annualized new and potential environmental costs to the petroleum industry likely will range between $17 billion and $25 billion by the end of the 1990s. Adding new costs to the current level of spending yields total estimated environmental costs of $26 billion to $33 billion in the year 2000.

The aggregated new and future cost estimates are similar in magnitude to estimates made in a similar, previous study completed in 1991. Several individual cost estimates used in the earlier study do not explicitly appear in the current study. Other estimates were revised, and several new cost estimates were added. Estimates for several provisions in the Clean Air Act Amendments of 1990, for example, fit into the latter category.

Based on current environmental spending and the estimated increase in annual expenditures of $17 billion to $25 billion, it is estimated that the petroleum industry may incur about 14 to 17 percent of national environmental expenditures in the year 2000. This would be a larger share than the industry incurred in the mid-1980s, but the lower end of this range approximates the industry's share in the mid-1970s and in 1980.

In considering the cost estimates presented in this paper, two factors should be noted. First, given the quality of the data available and the uncertainties associated with them, aggregate estimates for new and

Table ES-1.

New and Potential Federal Environmental Costs to the U.S. Petroleum Industry

Requirement Domain/ Requirement	Compliance Date	Estimated Initial Costs ($ mil)	Estimated Annual Costs ($ mil)	Estimated Annualized Cost ($ mil)	Cost Estimate Source(s)
Air					
Benzene NESHAPS	4/93	706 - 1,030	52	135 - 173	API
Phase II RVP Reductions	5/92	NA	NA	483 - 1,669	EPA and API
Diesel Fuel Sulfur Reduction	10/93	3,976[a]	388 - 895	388 - 1,404	EPA and NPRA[b]
Clean Air Act Amendments of 1990:					
Stage II Controls at Service Stations	1993-1994	NA	NA	324	API
Nonattainment Controls at Refineries	1995-1996	1,105	19 - 92	137 - 222	Bechtel/NPC[b]
Clean Gasoline:					
Oxygenated Gasoline & RFG Phase I	1992-1995	NA	NA	1,571 - 3,121[c]	API (using other sources)[d]
RFG Phase II	2000	NA	NA	601 - 5,366[c]	API (using other sources)[d]
*Air Toxics -- MACT Standards	1995-2000	1,325 - 1,994	71 - 593	264 - 906	API
Permitting	11/94	0	43	43	Bechtel/NPC
Emission Standards for OCS E&P Facilities	9/94	NA	NA	5 - 29	EPA
*Marine Vapor Controls	1996	2,458 - 3,177	NA	655 - 775	EPA

Table ES-1. (Continued)

New and Potential Federal Environmental Costs to the U.S. Petroleum Industry

Requirement Domain/ Requirement	Compliance Date	Estimated Initial Costs ($ mil)	Estimated Annual Costs ($ mil)	Estimated Annualized Cost ($ mil)	Cost Estimate Source(s)
Waste					
Scope of Toxicity Characteristic Rule	1993-1995	NA	NA	0 - 2,931	API (using other sources)[d]
Corrective Action at Hazardous Waste Facilities	1996	NA	NA	340	EPA
Modifications to Land Disposal Restrictions Promulgated in 1990	1995	5,000	181	768	API
Land Disposal Restrictions -- Primary Sludge	1993-1994	0	40 - 47	40 - 47	EPA
Water					
Discharge Standards for Offshore Exploration and Production	11/93	2,583[e]	646[e]	32 - 968	EPA and Gruy (for API)
*Discharge Standards for Coastal and Onshore Exploration and Production	1997	0 - 2,093	88 - 406	88 - 651	EPA and ICF (for DOE)
*Underground Injection Controls	1996	0 - 24,295	86 - 593	86 - 3,446	ICF (for DOE)
*Revised Effluent Standards for Refineries	1997	7,909	438 - 876	1,367 - 1,805	Bechtel/NPC[f]
Great Lakes Water Quality	1996	78 - 292	36 - 64	45 - 98	Ohio Petrol. Council

Table ES-1. (Continued)

New and Potential Federal Environmental Costs to the U.S. Petroleum Industry

Requirement Domain/ Requirement	Compliance Date	Estimated Initial Costs ($ mil)	Estimated Annual Costs ($ mil)	Estimated Annualized Cost ($ mil)	Cost Estimate Source(s)
Spill Prevention, Response, and Compensation					
Above-ground Tank Spill Prevention:					
Revised SPCC Program	1995	NA	NA	73	API (using EPA data)
*Secondary Containment	1995	17,400 - 33,200	0	1,984 - 3,833	Gruy (for API) and API
Double Hulls on U.S. Tankers	1995-2015	NA	NA	531	TBS (for USCG)
Vessel Financial Responsibility	1995	0	122	122	API (using USCG data)
Oil Spill Response Plans:	1993-1994				
Vessels		NA	NA	184 - 318	Mercer (for USCG)
Marine Transportation-Related Facilities		NA	NA	82	USCG[b]
Facilities with Above-ground Storage Tanks		121	52	63	API (using EPA data)
Onshore Oil Pipelines		167 - 841	142 - 706	169 - 843	API (using RSPA data)
Discharge Removal Equipment for Vessels	1996	NA	NA	18	USCG
Multimedia					
*Expansion of Toxic Release Reporting	1995	211	133	170	Dames & Moore (for API)

Table ES-1. (Continued)

New and Potential Federal Environmental Costs to the U.S. Petroleum Industry

* Specific requirements are expected from a federal agency but have not yet been proposed.

[a] Only estimate for upper range amount is available.

[b] Some calculations were made by API (in addition to any calculations either to convert cost estimates to 1991 dollars or to annualize costs).

[c] Although cost estimates are calculated on an annual basis, requirements vary seasonally. Care should be taken when interpreting these estimates on a per gallon basis.

[d] Estimate(s) was (were) made by API based on data from one or more other sources, as follows (see text for additional details):

Requirement	Sources of Data
Clean Gasolines	EIA, DRI, NPC, Auto/Oil, and API
Scope of Toxicity Characteristic Rule	EPA and API

Note: NA means "not available."
Estimates are in 1991 dollars.
Initial costs of some requirements are annualized differently than others. See the text for explanations of how each was calculated.
Compliance dates for some requirements are estimates.
Actual costs of final requirements may differ from those estimated based on proposed requirements.

Table ES-2.

Highly Uncertain Potential Federal Environmental Requirements for the Petroleum Industry for Which Potential Cost Estimates are Available

Requirement Domain/Requirement	Estimated Initial Costs ($ mil)	Estimated Annual Costs ($ mil)	Estimated Annualized Costs ($ mil)	Cost Estimate Source(s)
Air				
Clean Air Act Amendments of 1990:				
Air Toxics -- Residual Risk Requirements	0 - 5,671	0 - 700	0 - 1,492	API
Phase Out of Hydrogen Fluoride	3,142	214 - 427	583 - 796	Bechtel/NPC
Waste				
RCRA Reauthorization Legislation:				
Exploration and Production Wastes	4,438 - 56,447	1,494 - 3,302	2,015 - 9,932	ICF (for DOE) and Gruy (for API)
Surface Impoundments at Refineries	3,377 - 5,483	117 - 190	475 - 772	API
Water				
Clean Water Act Reauthorization:				
Stormwater Control	3,178	40 - 138	413 - 511	Bechtel/NPC
Effluent Fees	NA	32	32	CRS
Spill Prevention, Response, and Compensation				
Above-ground Tank Legislation	9,159 - 12,634	270 - 440	1,252 - 1,820	Gruy (for API)

Note: Estimates are in 1991 dollars.
Initial costs of some requirements are annualized differently than others. See the text for explanations of how each was calculated.

Table ES-3.

New and Potential Federal Environmental Requirements for the Petroleum Industry for Which Little or No Cost Information is Available, by Requirement Domain

Air

- Fuel Requirements for Fleets
- Fuels and Fuel Additives/Section 211 Test Rule
- Clean Air Act Amendments of 1990: Detergent Additives to Gasoline
- Revised RVP Test Method for Gasoline and Alcohol Blends
- Clean Air Act Amendments of 1990: Air Toxics -- Accidental Releases
- Air Toxics -- Phase Out of Halons
- Global Climate Change

Water

- Stormwater Permits
- Class V Injection Wells
- Sediment Analysis and Remediation
- Legislation to Prevent Offshore Leasing
- Clean Water Act Reauthorization Legislation: Wetlands and Effluent Standards for Sectors other than Refining

Waste

- RCRA Reauthorization Legislation: Nonhazardous Waste Management, Incineration, and Interstate Transport of Waste
- Groundwater Protection/ Corrective Action Legislation
- Used Oil
- Land Disposal Restrictions for Wastes Newly-Classified as Hazardous -- TC Waste and Contaminated Soil
- Hazardous Waste Identification Rule
- Hazardous Waste Listing
- Air Emissions from Treatment, Storage, and Disposal Facilities
- New Oil and Grease Test for NPDES Permits
- RCRA Definition of Wastewater Treatment Tank
- Superfund Reauthorization
- NORM

Spill Prevention, Response, and Compensation

- Design Standards for Tank Cars
- Financial Responsibility for Offshore Facilities
- Natural Resource Damage Assessments

Multimedia

- Pollution Prevention Directives
- Pollution Prevention Plan Legislation
- EPA Update of Potency Factors for Toxic Pollutants
- Reauthorization of the Endangered Species Act

potential costs should be treated as approximations. Second, an assessment of the full impacts of new environmental requirements would entail more than an examination of potential expenditures. As the petroleum industry adjusts to new requirements over the long term, the economic behavior of many sectors of the U.S. economy may be affected. A comprehensive analysis of impacts would trace the effects of new requirements on the U.S. economy and assess the resulting costs in relation to the benefits brought about by the requirements.

I. Introduction and Methodology

Many new federal environmental requirements affecting the petroleum industry have recently been established, and many others have been proposed. Some of these programs may bring significant benefits in terms of improved protection of human health and/or the environment. But while regulators or advocates of particular programs may consider the costs of individual requirements modest, the aggregate cost of many such piecemeal programs could be very high.

This paper, which updates a previous study,[1] surveys new and potential federal environmental requirements that will or may elicit significant compliance expenditures by the petroleum industry in the 1990s. This paper presents the compliance cost estimates currently available, aggregates them, and assesses their validity relative to historic and national trends.

A list of environmental requirements that could affect the petroleum industry in the 1990s and early 21st century was compiled from oil industry documents. Taxes and other policies that mostly involve the transfer of resources generally were not included. State requirements also were generally excluded, although some regional requirements were included. To qualify as "new," already-promulgated regulations were screened for when significant compliance expenditures likely began or would begin; regulations for which significant expenditures likely were made in 1991 or earlier were excluded from the analysis. The final list of requirements was checked for completeness by examining the Environmental Protection Agency's (EPA's) most recent agenda of regulatory actions.[2]

Cost estimates were collected from *Federal Register* notices, written studies, articles, and information supplied by American Petroleum Institute (API) staff. In some cases cost estimates were derived from relevant raw data; such derivations are described in the text. Estimates made by government agencies were generally found in *Federal Register* notices; a detailed search through government dockets for cost estimates was not practicable.

The cost estimates that seemed most complete and documented were used. Wherever possible, a range of cost estimates was specified, to indicate the uncertainty of potential costs. Annual or annualized costs were used when available. When sources provided capital or other initial cost information without annualizing, these costs generally were annualized at a rate of 10 percent annually over a period of twenty years. The text describes how annualized amounts were calculated. Since each environmental requirement is unique, different methodologies were used by different sources to estimate costs; aside from adjusting some estimates to avoid double-counting, the estimates were taken as given. Cost estimates made in 1990 or 1992 were usually treated as if they were made in 1991 dollars. In some cases cost estimates were adjusted to 1991 dollars using a general GNP deflator (for deflator values, see Appendix B).

The survey of various requirements is organized into three sections: the first covers those requirements for which cost estimates are available, the second examines cost estimates for proposed requirements that are very uncertain, and the third section qualitatively describes other new and potential requirements.

The aggregation of cost estimates through simulation and the methodology for assessing the data using information on current, historic, and national environmental spending trends are further described below.

II. Federal Environmental Requirements and Cost Estimates

A. Requirements for Which Compliance Cost Estimates are Available

Costs to the petroleum industry of various federal requirements to control air and water pollution and pollution from wastes have been estimated. Table 1 lists such requirements and the compliance estimates available. Most of the requirements listed have been finalized or proposed or are scheduled for proposal soon by a federal agency. It should be noted that some of the compliance dates listed in Table 1 are estimates, and that the actual costs of final requirements may differ from those estimated based on either proposed requirements or preliminary outlines of requirements that might be proposed.

1. *Air*

Benzene NESHAPS. EPA promulgated a final rule in March 1990 that regulates air emissions of benzene from wastewaters and other waste streams containing benzene at petroleum refineries, under the Clean Air Act's National Emission Standards for Hazardous Air Pollutants (NESHAPS) program.[3] Many refineries must make substantial changes to their wastewater collection and treatment systems in order to comply with the rule. In March 1992, EPA delayed the effectiveness of the final rule, pending clarification of some requirements.[4] Amendments were issued in January 1993,[5] with April 7, 1993 being the deadline for compliance or the obtaining of a compliance extension. EPA is currently considering promulgating an alternative compliance option that would be based on site-specific risk assessments.[6]

A joint survey by API and the National Petroleum Refiners Association (NPRA) in March 1991 and subsequent staff analysis found that a minimum of 66 refineries (representing 70 percent of U.S. refining capacity) would be required to install controls, based on the final rule promulgated in 1990.[7] Based on this survey, total (initial) compliance costs for petroleum refiners were estimated at $2 billion.[8] A second survey of refineries undertaken later in 1991 supported this estimate.[9]

A third survey, conducted by API in the summer of 1993, estimated lower benzene NESHAPS compliance costs. A primary reason for the smaller estimate is that the rule's requirements had changed from those promulgated in 1990: EPA provided greater flexibility by allowing several compliance options in its amendments issued in January 1993. The results of the third survey estimated initial costs of $706 million to $1,030 million; the lower estimate would apply only if EPA were to issue a site-specific risk assessment compliance option in the near future. The survey also indicated that annual costs would be $52 million.[10] Annualizing at a 10 percent discount rate over 20 years (by assumption), these costs amount to $135 million to $173 million.

Phase II RVP Reductions. In June 1990 EPA finalized Phase II of its program to reduce gasoline volatility under its Clean Air Act authority.[11] Phase II, which took effect in May 1992, limits gasoline volatility (i.e., the Reid Vapor Pressure (RVP)) to 9.0 psi or 7.8 psi, depending on the area in which the gasoline is sold. EPA estimated the costs of its proposed regulation to be $405 million per year for refiners, while a study done for API estimated costs of $1,490 million annually.[12] EPA's final rule lowered some RVP standards and raised others, and EPA estimated higher annual costs to refiners ($464 million, excluding Northeastern states).[13] The estimates of $464 million and $1,490 million specify the range of estimated costs, in $1990 and $1988, respectively. Converting both estimates to $1991 yields a range of estimated annualized costs of $483 million to $1,669 million.

It is important to note that EPA has promulgated further revisions to its RVP requirements, and that compliance with the revisions could involve additional costs to refiners. This is discussed in more detail in the section on revised RVP regulations for gasoline.

(Page 1 of 4)

Table 1.

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Diesel Fuel Sulfur Reduction	10/93	3,976[a]	388 - 895	388 - 1,404	EPA and NPRA[b]
Clean Air Act Amendments of 1990:					
Stage II Controls at Service Stations	1993-1994	NA	NA	324	API
Nonattainment Controls at Refineries	1995-1996	1,105	19 - 92	137 - 222	Bechtel/NPC[b]
Clean Gasoline:					
Oxygenated Gasoline & RFG Phase I	1992-1995	NA	NA	1,571 - 3,121[c]	API (using other sources)[d]
RFG Phase II	2000	NA	NA	601 - 5,366[c]	API (using other sources)[d]
*Air Toxics -- MACT Standards	1995-2000	1,325 - 1,994	71 - 593	264 - 906	API
Permitting	11/94	0	43	43	Bechtel/NPC
Emission Standards for OCS E&P Facilities	9/94	NA	NA	5 - 29	EPA
*Marine Vapor Controls	1996	2,458 - 3,177	NA	655 - 775	EPA

Table 1. (Continued)

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Scope of Toxicity Characteristic Rule	1993-1995	NA	NA	0 - 2,931	API (using other sources)[d]
Corrective Action at Hazardous Waste Facilities	1996	NA	NA	340	EPA
Modifications to Land Disposal Restrictions Promulgated in 1990	1995	5,000	181	768	API
Land Disposal Restrictions -- Primary Sludge	1993-1994	0	40 - 47	40 - 47	EPA
Water					
Discharge Standards for Offshore Exploration and Production	11/93	2,583[a]	646[a]	32 - 968	EPA and Gruy (for API)
*Discharge Standards for Coastal and Onshore Exploration and Production	1997	0 - 2,093	88 - 406	88 - 651	EPA and ICF (for DOE)
*Underground Injection Controls	1996	0 - 24,295	86 - 593	86 - 3,446	ICF (for DOE)
*Revised Effluent Standards for Refineries	1997	7,909	438 - 876	1,367 - 1,805	Bechtel/NPC[b]
Great Lakes Water Quality	1996	78 - 292	36 - 64	45 - 98	Ohio Petrol. Council

Table 1. (Continued)

New and Potential Federal Environmental Costs to the U.S. Petroleum Industry

Requirement Domain/ Requirement	Compliance Date	Estimated Initial Costs ($ mil)	Estimated Annual Costs ($ mil)	Estimated Annualized Cost ($ mil)	Cost Estimate Source(s)
Spill Prevention, Response, and Compensation					
Above-ground Tank Spill Prevention:					
Revised SPCC Program	1995	NA	NA	73	API (using EPA data)
*Secondary Containment	1995	17,400 - 33,200	0	1,984 - 3,833	Gruy (for API) and API
Double Hulls on U.S. Tankers	1995-2015	NA	NA	531	TBS (for USCG)
Vessel Financial Responsibility	1995	0	122	122	API (using USCG data)
Oil Spill Response Plans:	1993-1994				
Vessels		NA	NA	184 - 318	Mercer (for USCG)
Marine Transportation-Related Facilities		NA	NA	82	USCG[b]
Facilities with Above-ground Storage Tanks		121	52	63	API (using EPA data)
Onshore Oil Pipelines		167 - 841	142 - 706	169 - 843	API (using RSPA data)
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Multimedia					
*Expansion of Toxic Release Reporting	1995	211	133	170	Dames & Moore (for API)

Table 1. (Continued)

New and Potential Federal Environmental Costs to the U.S. Petroleum Industry

* Specific requirements are expected from a federal agency but have not yet been proposed.

[a] Only estimate for upper range amount is available.

[b] Some calculations were made by API (in addition to any calculations either to convert cost estimates to 1991 dollars or to annualize costs).

[c] Although cost estimates are calculated on an annual basis, requirements vary seasonally. Care should be taken when interpreting these estimates on a per gallon basis.

[d] Estimate(s) was (were) made by API based on data from one or more other sources, as follows (see text for additional details):

Requirement	Sources of Data
Clean Gasolines	EIA, DRI, NPC, Auto/Oil, and API
Scope of Toxicity Characteristic Rule	EPA and API

Note: NA means "not available."
Estimates are in 1991 dollars.
Initial costs of some requirements are annualized differently than others. See the text for explanations of how each was calculated.
Compliance dates for some requirements are estimates.
Actual costs of final requirements may differ from those estimated based on proposed requirements.

Diesel Fuel Sulfur Reductions. In August 1990 EPA promulgated standards that require refiners to reduce the sulfur content of on-highway diesel fuel to 0.05 weight percent by October 1993.[14] A survey completed by NPRA in 1986 estimated that meeting this requirement would cost refiners $3,313 million for capital and $340 million annually for operating activities. Using a discount factor of 15 percent for capital, NPRA estimated annualized costs of $1,170 million ($1986).[15] Converting these to $1991 yields capital costs of $3,976 million, annual costs of $408 million, and annualized costs of $1,404 million. Based on cost analyses prepared for its proposed rule in 1989,[16] EPA estimated that annual costs would be $360 million to $830 million ($1989);[17] this is $388 million to $895 million in $1991. The range of $388 million to $1,404 million thus reflects the range of annualized EPA and NPRA estimates, in $1991.

Clean Air Act Amendments of 1990. According to the Bush administration in 1990, overall U.S. compliance costs resulting from the Clean Air Act Amendments of 1990 are expected to total $25 billion a year.[18] This estimate, however, may be low; it appears to exclude the costs of some major provisions of the Amendments.[19] Cost estimates are available for five provisions that are expected to have significant effects on petroleum industry operations: nonattainment, clean gasolines, air toxics, permitting, and off-shore exploration and production emission standards. All petroleum industry sectors will have to comply with some new requirements.

Clean Air Act Amendments of 1990: Non-Attainment. Title I of the Amendments requires that stronger measures be implemented to control emissions in areas that have difficulty meeting national air quality standards such as those for ozone, carbon monoxide, particulates, and sulfur dioxide. States are required to revise their State Implementation Plans (SIPs) for their nonattainment areas; new strategies to control emission must be adopted by 1994 or 1995. A state's selection of controls will depend in part upon the particular types of air pollution problems in that state and the degree of nonattainment.

Petroleum refiners, marketers, and transporters will face new requirements once SIPs are revised. Cost estimates are available for "Stage II" control requirements at service stations and control requirements for refiners. Requirements for marine loading facilities are discussed separately.

Clean Air Act Amendments of 1990: Non-Attainment -- Stage II Controls at Service Stations. Title I includes a series of provisions outlining Stage II requirements for refueling vapor recovery systems at service stations (stations that sell very low quantities of gasoline are exempt). EPA, however, is granted some flexibility in implementing some Stage II requirements. The three main requirements outlined in the Amendments are as follows: (1) For areas "severely" or "seriously" out of attainment, Stage II controls are mandatory, beginning in 1993. (2) For the entire Northeast Ozone Transport Region (which includes some areas in attainment with ozone standards), Stage II or a comparable measure recommended by EPA is required. An analysis of comparable measures is due from EPA in November 1993; requirements are to take effect 12 months after EPA completes its analysis. (3) For "moderate" ozone nonattainment areas, the Amendments require Stage II controls beginning in 1993; however, relief for these areas is allowed once EPA promulgates requirements (which were due by November 1991) for equipping cars and trucks with onboard refueling vapor recovery systems ("onboard controls").

EPA issued a decision in April 1992 not to require onboard controls,[20] but in January 1993 a federal appeals court ruled that EPA must issue these standards.[21] EPA has since reopened a 1987 proposal to require onboard controls,[22] and plans to finalize the rule by January 1994.[23] This ruling may not significantly reduce costs incurred by service stations in moderate nonattainment areas. Service stations built after the Clean Air Act Amendments were enacted were to have installed Stage II controls by May 15, 1993, and by November 15, 1993 many more service stations will be required to have Stage II controls. In addition, even after onboard control rules

are promulgated, states will have discretion whether or not to keep requiring Stage II controls in moderate nonattainment areas. It is possible, however, that Stage II controls for some service stations in moderate nonattainment areas will be cancelled or discontinued, and some capital and/or operating costs may be avoided.

API has estimated that the net present value of Stage II controls (calculated from 1992 through 2021, at a discount rate of 5 percent), if controls are put in place in moderate as well as severe and serious nonattainment areas, to be $4,032 million ($1992).[24] Converting the net present value to an annualized cost estimate (using the 5 percent and 20 year assumptions) yields $324 million per year. This estimate could overestimate costs, depending on the degree of impact the onboard control requirements will have. Alternatively, this estimate could underestimate costs due to the possibility that Stage II controls could be required throughout the Northeast Ozone Transport Region.

Clean Air Act Amendments of 1990: Nonattainment -- Controls at Refineries. About 70 percent of U.S. refining capacity is located in ozone nonattainment areas.[25] Petroleum refineries also are located in carbon monoxide, particulate, and sulfur dioxide nonattainment areas as well. Refiners may face such requirements as emissions offsets for new equipment, emissions inventory reporting, and volatile organic compound (VOC) and/or nitrogen oxide (NOx) emissions reductions on existing stationary source equipment. For example, refiners may have to modify catalytic processes, boilers and/or heating equipment in order to control NOx.

A study by Bechtel Corporation (for the National Petroleum Council) has examined costs to refiners of controlling NOx (and other pollutants) in nonattainment areas.[26] Bechtel estimated capital costs of $1,105 million for controlling NOx in nonattainment areas. Annual costs, which rise as requirements are implemented, are estimated at $7 million to $92 million.[27] Annualized over 20 years at 10 percent (by assumption), this amounts to $137 million to $222 million per year. This cost range could underestimate nonattainment requirement costs to refiners, because NOx reduction is the only type of release reduction considered.

Clean Air Act Amendments of 1990: Clean Gasolines. Title II establishes a number of new programs, including two new, overlapping programs requiring that petroleum companies produce "clean gasolines." Clean gasoline requirements and costs are discussed here. Clean Air Act Amendment requirements for "clean fuel fleets" are discussed in a separate section (Fuel Requirements for Fleets).

Refiners will be affected by clean gasoline requirements; the distribution, storage, and marketing sectors of the petroleum industry will also bear added costs, as carriers must ensure that they are distributing the correct fuels at the right time of year. The first group of requirements takes effect in the 1992-1995 timeframe. Gasoline with specific oxygen requirements was made available in November 1992 on a seasonal basis in areas that exceed the carbon monoxide air quality standard. Beginning in 1995, reformulated gasoline (RFG) must be sold year-round in the severest, large nonattainment areas. Also in 1995 the "antidumping" provisions of the Amendments will prohibit refiners from transferring regulated gasoline components from clean gasolines to gasoline sold in other areas of the country. A second group of requirements will take effect in the year 2000, as reformulated gasoline requirements will be made more stringent, and, for areas not in compliance with carbon monoxide standards by December 2000, the oxygen requirement for oxygenated gasoline may be increased.

Oxygenated Gasoline and Reformulated Gasoline Phase I. Title II required that by November 1, 1992 the oxygen content of fuels be at least 2.7 weight percent in areas that have not attained the standard for carbon monoxide. At present, there are about 40 such areas. In October 1992, EPA finalized labeling requirements and guidelines for credit programs.[28]

Title II also requires that, by January 1, 1995, RFG must become the sole fuel sold year-round in the 9 U.S. cities with the highest ozone levels; other cities with less severe nonattainment may "opt in" to the program. RFG must meet oxygen, benzene, and heavy metal content level requirements and limits. (Oxygen contents must be at least 2 percent year round.) RFG Phase I must also meet emissions restrictions for NOx and toxic air pollutants (TAPs) emissions year-round. During the high ozone season (summer), VOCs must be reduced.

In August 1991, representatives from EPA, petroleum and other industries, states, and environmental groups entered into an agreement in principle to conclude a negotiated rulemaking on clean fuels; this was the basis for EPA's proposed rulemaking in April 1992.[29] Compliance with reformulated gasoline requirements is to be certified with either a simple or complex emission model. The April 1992 proposed rule outlined a simple model to be used in 1995 and 1996. In February 1993, EPA proposed a complex model for 1997 and later.[30] The complex model is expected to allow more flexibility than the simple model. EPA's February 1993 proposal also included provisions that could increase the use of ethanol in RFG. Such an increase would raise the average RVP of fuel sold. To offset this, EPA would require refineries to provide a lower RVP gasoline for blending with non-ethanol oxygenates. Final reformulated gasoline requirements are expected by the end of 1993.

Appendix A shows in detail how total costs are estimated, based on the seasonality of requirements, estimated ranges of potential market sizes, and estimated costs per gallon. Costs of $1,571 million to $3,121 million per year are estimated for oxygenated gasoline and RFG Phase I requirements together.

Reformulated Gasoline Phase II. Standards stricter than those for Phase I reformulated gasoline are to take effect in the year 2000, outside California. VOC and TAP emissions are to be reduced below levels permitted by RFG Phase I requirements. Phase II RFG will be required in those areas required to use RFG Phase I. It is unclear whether areas opting into the Phase I program will be permitted to continue using Phase I RFG after the year 1999.[31] Certification must be made using the complex model. In November 1992, the California Air Resource Board finalized requirements for California's Phase II reformulated gasoline, which become effective in 1996. EPA proposed Phase II performance standards in February 1993 for states other than California[32] and expects to finalize these requirements in December 1993.

Based on seasonality, estimated ranges of potential market sizes, and estimated costs per gallon, Appendix A estimates total costs of $601 million to $5,366 million per year for RFG Phase II. These costs are over and above costs incurred refining Phase I RFG.

Although cost estimates for clean gasolines are calculated on an annual basis, the fact that requirements vary seasonally should be considered when interpreting these cost estimates on a per gallon basis.

Clean Air Act Amendments of 1990: Air Toxics -- MACT Standards. Title III of the Clean Air Act Amendments requires that EPA promulgate new control standards for most sources of 189 hazardous air pollutants (HAPS). A number of the substances to be regulated are found in petroleum raw materials, products, and by-products. The first phase of regulations will, over the next 8 years, set Maximum Achievable Control Technology (MACT) standards for various categories of industrial facilities. As standards are finalized, businesses must comply with them within 3 years. In the second phase of regulation, which governs "residual risks" (risks remaining after compliance with MACT standards), particular facilities may be more stringently regulated. Cost estimates for this second phase of requirements are discussed in a separate section below. It should be noted that both MACT and residual risk requirements will seek to limit releases to air made on a routine basis.

EPA has determined the industry categories for which MACT standards will be developed. In addition, EPA has published a draft schedule[33] for final rule promulgation. EPA plans to finalize this schedule in October 1993. The draft schedule for final rule promulgation includes these listings for various sectors of the petroleum industry:

Oil and Natural Gas Production: 11/15/97
Petroleum Refineries (Catalytic Cracking and Reforming Units, Sulfur Plant Units): 11/15/97
Petroleum Refineries (Other sources not listed): 11/15/94
Gasoline Distribution (Stage 1): 11/15/94

In addition, MACT standards for synthetic organic chemical manufacturers, proposed in December 1992, will affect petroleum refiners that manufacture certain chemicals or products (e.g., methanol).[34] EPA expects to finalize this rule in November 1993.

A study conducted for API in 1989 and updated in early 1990[35] (i.e., before the Clean Air Act Amendments were finalized) attempted to predict what MACT controls would be required, and then it estimated costs to the production, marketing, transportation, and refining sectors of the petroleum industry. A discount rate of 10 percent was assumed for capital costs; various types of required equipment were assumed to last different lengths of time. A recent analysis by API has estimated ranges of potential MACT compliance costs, based on different levels of regulatory stringency and the cost estimates contained in the 1990 study.[36] This analysis estimated costs as follows: $1,325 million to $1,994 million in initial capital costs, $71 million to $593 million in annual costs, and annualized costs of $264 million to $906 million.

These cost estimates could under- or over-state potential costs. If EPA allows "bubbling" (a form of averaging emissions within facilities) actual costs for some facilities could be lower than estimated. On the other hand, costs may be higher than estimated for some firms that significantly modify or reconstruct facilities (e.g., to comply with other environmental requirements) before EPA's MACT standards are promulgated. Such modifications or reconstructions could be approved and completed based on case-by-case determinations of MACT requirements (performed by states), but if the nationally-applicable federal standards are more stringent, total MACT compliance costs may exceed what they would have been if the modifications or reconstructions were originally undertaken in accordance with the level of stringency in the federal standards. Potential costs for exploration and production facilities may be particularly difficult to estimate at present, since the way in which many of them are classified by EPA (i.e., as major or nonmajor emission sources) could significantly affect their compliance costs.

API is currently in the process of developing cost estimates for implementing refinery control options to comply with potential MACT requirements. These new estimates are expected to be available in the summer of 1994.

Clean Air Act Amendments of 1990: Permitting. Title V directs states to establish new operating permit programs (that meet new federal requirements) for sources of air emissions. EPA published its final permitting rule in July 1992.[37] Initial permit applications generally must be submitted to states by November 15, 1994; states will have three years within which to approve permits. Permits may be approved for at most a five year period. EPA also plans to issue federal operating permit requirements that would be applicable in states that fail to submit an appropriate state program. Almost all sources of significant emissions are required to obtain permits; after permits are granted, facilities must monitor and report on their emissions. Title V requires that states levy annual fees of at least $25 per ton (indexed for inflation) of regulated emissions (except carbon monoxide); fees collected will go to the states.

A study by Bechtel Corporation (for the National Petroleum Council) has estimated annual permitting costs to refiners of $43 million.[38] This probably

underestimates total permitting costs to the petroleum industry, since most (if not all) marketing terminals will be required to obtain permits. It also is possible that some exploration and production facilities and some transportation facilities may be required to obtain permits.

Clean Air Act Amendments of 1990: Air Emission Standards for OCS Exploration and Production Facilities. In September 1992, under authority of the Amendments, EPA promulgated final regulations for oil and gas exploration and production activities located on the Outer Continental Shelf (OCS).[39] The Amendments require that OCS sources within 25 miles of states' boundaries comply with the same standards applicable onshore. EPA's final rule is applicable to all OCS exploration and production facilities, except those located in central and western portions of the Gulf of Mexico. Existing sources are to comply with the new rule by September 1994. EPA estimated that the annualized costs of this regulation would be $5 million in 1997, growing to $29 million by the year 2010; the increase is attributed mainly to projected increases in exploration and production activity.[40]

Marine Vapor Controls. To decrease VOC emissions, the Clean Air Act Amendments of 1990 require EPA to promulgate final standards for "Stage II"-type controls on marine terminals. EPA plans to propose standards for loading terminals by April 30, 1994 and finalize them by April 30, 1995. Facilities in the marketing, transportation, and refining sectors of the petroleum industry may be affected.[41] EPA also has the authority to more stringently regulate unloading facilities.

There are approximately 1,800 U.S. terminals that load crude oil, gasoline, and other petroleum products (e.g., kerosene).[42] EPA has estimated that the capital costs of installing Stage II-type controls at all 1,800 facilities will total $2,120 million to $2,740 million ($1987), and that annualized costs will range from $565 million to $669 million ($1987).[43] Capital costs were generally annualized at a rate of 10 percent annually over 10 to 20 years, depending upon expected life of the equipment. Converting these estimates to $1991 yields capital costs of $2,458 million to $3,177 million, and annualized costs from $655 million to $775 million.

The above estimates may overstate or understate the true costs of marine vapor controls as they will be proposed by EPA. They may overstate costs because not all 1,800 loading terminals may be required to install controls. For example, EPA may choose to exempt some terminals from the rule.[44] On the other hand, the costs per terminal used in EPA's analysis may understate the true costs of added controls. In 1990 API collected cost data for several marine vapor control systems that were being installed by API member companies and affiliated industry organizations. API's data indicate a wide range of capital costs per terminal, the highest of which are considerably higher than those used by EPA (e.g., $27 million vs. $14 million).[45] In addition, if EPA were to increase the controls at unloading facilities beyond those required by current regulations, compliance costs would be higher than estimated.

2. *Waste*

Scope of Toxicity Characteristic Rule. In March 1990 EPA issued a final rule, under the authority of the Resource Conservation and Recovery Act (RCRA), requiring that wastes failing its new toxicity test be managed as hazardous wastes.[46] This rule significantly expanded the universe of hazardous wastes, and it has affected all sectors of the petroleum industry. Hazardous waste generators were to comply with the rule by March 1991. Several regulatory issues concerning the scope of the final rule are still being resolved; three could significantly affect the petroleum industry.

First, the March 1990 final rule temporarily deferred application of the toxicity characteristic (TC) rule for underground storage tank (UST) remediations. (These wastes are regulated under Subtitle I of RCRA.) EPA proposed a permanent exemption for

these wastes in February 1993,[47] and could finalize its decision regarding this issue in 1993 or 1994. Although EPA did not estimate the total costs of regulating UST contaminated media in its proposed rule,[48] EPA has stated that management of the wastes under Subtitle C would increase treatment costs from $55 per cubic yard of contaminated soil to as much as $1,060. EPA also estimated total annual costs nationwide of up to $4 billion for each of the first five years.[49]

Under Subtitle C, annualized permitting costs for service stations would be $676 million, based on a 1989 API analysis that annualized costs over 10 years, at 10 percent.[50] Updating this to $1991 yields an estimate of $729 million. In 1991, API estimated that the UST deferral would save all owners or operators of USTs a total of $33 billion (excluding costs incurred due to permitting changes). This estimate is based on EPA's estimate that 300,000 facilities owning USTs are significantly contaminated; in 1991 API estimated that cleanups would cost at least $110,000 per facility.[51] According to EPA data, service stations comprise about 41 percent of UST-owning facilities.[52] Thus, it is estimated that costs to service stations of doing UST cleanups under the toxicity characteristic rule would total $13,530 million. Annualizing this over 10 years at 10 percent yields $2,202 million in annual costs. Thus, the total annualized costs associated with the UST exemption (i.e., total permitting and cleanup costs) could amount to $2,931 million.

Second, in December 1992, in response to requests from a number of states, EPA proposed to defer application of the toxicity characteristic rule to petroleum contaminated media (other than those from USTs) for a period of three years.[53] Such a suspension would apply only in states that have programs for effective cleanup enforcement. EPA could make a final decision regarding this suspension in 1993. No quantitative estimates as to the value of this deferral are available. However, EPA has stated that ". . . the amount of TC petroleum-contaminated soil affected annually by the suspension appears to be on the order of hundreds of thousands of cubic yards. Depending on the actual unit cost savings, the total national cost savings due to the TC suspension for petroleum-contaminated media may be in the tens or hundreds of millions of dollars per year for the duration of the three year suspension."[54]

Third, in April 1991 EPA extended until January 25, 1993 compliance for reinjected water from hydrocarbon recovery.[55] Unless EPA again extends the compliance date, affected operations at petroleum refineries, marketing terminals, and bulk plants may be modified or discontinued; no cost estimates are currently available.

It is estimated that total annualized costs of defining the scope of the toxicity characteristic rule range between $0 and $2,931 million, depending upon whether or not the UST deferral becomes a permanent exclusion. Actual costs may be lower (i.e., there even could be net savings) if the exclusion for non-UST petroleum contaminated media is deferred for three years or made permanent. However, if the exclusion/deferral for reinjected media is permanently removed, costs resulting from the toxicity characteristic test could increase.

Corrective Action at Hazardous Waste Facilities. EPA's corrective action requirements under RCRA are being made both more stringent and more flexible. In July 1990 EPA proposed more stringent requirements for corrective action for solid waste management units at facilities that treat, store, or dispose of hazardous wastes.[56] The Office of Management and Budget (OMB) has required that the Agency redo its original regulatory impact analysis for the proposed rule. A revised economic analysis by EPA is expected by summer 1994;[57] a draft has been submitted to EPA's Science Advisory Board for review. At present, EPA is unsure whether or not it will repropose the rule after the revised economic analysis is completed. A final rule is not expected until 1994 or 1995.[58]

On February 16, 1993 EPA finalized a rule (the "CAMU" rule) that will allow for greater flexibility in

conducting corrective actions.[59] EPA expects that this rule will reduce the need for incineration and result in greater use of innovative technologies. EPA also estimates that the rule will save a total of $16.6 billion to $26.6 billion nationally, primarily in avoided incineration costs.[60]

EPA's draft regulatory impact analysis, using a discount rate of 7 percent, estimated the present value of total costs of the proposed rule to be $19 billion.[61] This estimate accounts for provisions in the CAMU rule (as it was proposed),[62] and takes into account costs incurred through monitoring, treatment, investigation, and other activities.[63] The draft analysis estimates total present value costs to the petroleum industry (again using a discount rate of 7 percent) to be $3.6 billion.[64] Annualized over 20 years,[65] this amounts to $340 million per year. This estimate appears to be for the petroleum refining sector only.[66]

EPA's draft analysis states that the average present value cost per petroleum (refining) facility would be $10 million.[67] A recent study conducted for API estimated potential corrective action compliance costs for a hypothetical, large and complex petroleum refinery. This study estimated that, depending on the stringency of requirements, initial (capital) costs could be from $62 million to $154 million and annual (operating) costs could be from $1.8 million to $1.9 million.[68] The higher API estimates assume the level of stringency in EPA's proposed rule. When annualized over 20 years at 7 percent (for consistency), API's cost estimate for the proposed rule is considerably larger than EPA's estimate: $16.4 million v. $0.9 million. This difference may be at least partly explained by differences in basic assumptions: EPA's estimate is for an "average" refinery, whereas the API estimate is for a large, complex refinery.

It is possible, however, that EPA's analysis does underestimate potential costs of its proposed rule. In contrast to EPA's estimated total costs of $19 billion, the RCRA Corrective Action Project, an industrial coalition, estimated total costs of $102 billion to $850 billion.[69] A study conducted at the University of Tennessee has recently estimated total RCRA corrective action costs of $170 billion to $377 billion; the study's "best guess" estimate is $234 billion.[70]

Modifications to Land Disposal Restrictions Promulgated in 1990. Under authority of RCRA, EPA promulgated regulations in June 1990 that restricted the disposal on land of certain petroleum refining hazardous wastes.[71] Under these restrictions, specified wastes cannot be disposed of on land without treatment or the approval of a "no migration petition" for land treatment,[72] unless the wastes are covered by a variance. Five petroleum refinery wastes listed as hazardous prior to 1990 are subject to the land disposal restrictions. Other land disposal restrictions apply to refinery wastes found to be "characteristically" hazardous through testing.

In September 1992 the D.C. Circuit of Appeals ruled that surface impoundments that are part of Clean Water Act treatment systems receiving "characteristically" hazardous wastes potentially could become subject to additional RCRA requirements.[73] The court also ruled that EPA can require that some characteristic wastes be treated to below-hazardous limits. EPA has begun a rulemaking effort that will address these issues (and others). It is possible that some aspects could become final in 1994. API has estimated that initial compliance costs for refineries could total $5,000 million and that their annual operating costs of compliance could total $181 million.[74] Annualized at 10 percent over 20 years (by assumption), costs are $768 million. Actual costs could be higher, as other sectors of the petroleum industry also generate wastes that could be affected by the court's decision.

Land Disposal Restrictions for Wastes Newly-Classified as Hazardous -- Primary Sludge. In November 1990, under authority of RCRA, EPA issued a final rule listing petroleum refinery primary and secondary separation sludges as hazardous wastes, effective May 1991.[75] Certain floats from surface impoundments and other units also were regulated by

the rule. EPA finalized land disposal restrictions for these wastes on August 18, 1992.[76] This final rule granted capacity variances for certain sludges for either one year or two years, depending on how the sludges were generated; compliance is required by June 1993 or June 1994. EPA estimated annual costs of $40 million to $47 million.[77] There are a number of ways this range may underestimate actual costs. For example, EPA excluded sludges generated in California from its analysis, and EPA may have underestimated the total quantities of primary sludge to be managed.[78]

3. *Water*

Discharge Standards for Offshore Exploration and Production. In March 1993, under authority of the Clean Water Act (CWA), EPA finalized new discharge standards that would affect offshore exploration and production operations.[79] The rule limits effluent discharges by establishing new source performance standards and limitations based on "best available" technologies and best conventional pollutant control technologies.

EPA estimated annualized costs to decline from $122 million in the first year to $32 million in the 15th year for drilling fluids, drill cuttings, and produced water.[80] This breaks down as follows: $18.8 million per year for drilling fluids and cuttings, $103.1 million per year for produced waters in year 1, and $13.4 million per year for produced waters in year 15.[81] It should be noted that these cost estimates are for the Gulf of Mexico only.

Deadlines for compliance with the new standards will be established by EPA Regions (principally Regions IV and VI) when general permits are developed or reissued. EPA regions also have the discretion to make their permit requirements more stringent than the federal guidelines. In fact, on November 19, 1992 EPA Region VI issued a new National Pollutant Discharge Elimination System (NPDES) permit for oil and gas facilities operating in federal waters on the Outer Continental Shelf of the Gulf of Mexico.[82] Facilities are to comply by November 1993. This permit regulates discharges into surface waters. As noted by EPA, the final permit incorporates substantive changes to the proposed permit, including recalculations of dilutions used for toxicity limits.[83] The petroleum industry is particularly concerned about these recalculations, since the new toxicity limits could force many facilities to reinject produced water rather than discharge it. API is presently litigating this final permit;[84] in response, EPA has proposed modifications.[85]

A study done for API by Gruy Engineering estimated the costs of injecting all waters produced by offshore exploration and production operations. The study estimated capital costs of $2,583 million and operating costs of $646 million in 1993 ($1990) for all U.S. offshore oil and gas facilities,[86] although this study found that significant numbers of fields would be abandoned and reserves would be lost as a result of implementation of the proposed rule. The Gruy estimates, annualized at a discount rate of 10 percent over 20 years (by assumption), are $949 million.

Using the EPA and Gruy findings, a range of total compliance costs can be estimated. The low end of the range would be EPA's annualized cost for the federal standards in year 15: $32 million. The high estimate of costs would include EPA's estimated compliance costs for drilling cuttings and fluids, $18.8 million, plus the $949 million in annualized costs for produced water reinjected (based on the Gruy estimates); this totals $968 million. The higher cost estimate assumes, in effect, that the final permit for the Gulf of Mexico remains unchanged and that other EPA Regions also adopt equally stringent requirements in their permit standards.

Discharge Standards for Coastal and Onshore Exploration and Production. EPA is developing effluent limitation requirements and new source performance standards for coastal oil and gas exploration, development, and production operations. The new regulations could ban onshore and coastal surface discharges of drilling muds, drill cuttings, and

produced brines. EPA is expected to propose regulations in 1995 and finalize them in 1996.

EPA Region VI recently proposed a general permit that bans coastal discharges of produced waters and sands.[87] EPA estimated annual costs to Louisiana and Texas with respect to produced water to be $73.9 million and $13.8 million, respectively,[88] and costs with respect to produced sands of $0.4 million and $0.3 million (respectively).[89] Thus, costs to Louisiana and Texas are estimated to total $88.4 million per year.

Texas and Louisiana also have included bans on discharges in proposed permits covering drilling fluids and cuttings and other wastes.[90] Compliance with the restrictions in these proposed permits has been estimated by EPA to be up to $183,450 per well.[91]

Using an API survey and other studies, ICF Resources has estimated that potential costs to the coastal and onshore exploration and production sector of banning the discharge of produced water could be $0 to $1,868 million initially, with additional annual costs from $0 to $362 million ($1988).[92] These cost estimates vary with the degree to which discharges of wastes are banned. Annualized at 10 percent over 20 years (by assumption), the costs range from $0 to $581 million. Converted to $1991, initial costs are $0 to $2,093 million, annual costs are $0 to $406 million, and the annualized cost range is $0 to $651 million.

Using the cost estimates by EPA Region VI and ICF Resources, total annualized costs of banning the discharge of coastal and onshore exploration and production wastes range from $88 million to $651 million. The low estimate assumes only Region VI coastal facilities must comply with the ban; the high estimate assumes all (coastal and onshore) facilities must comply. This range underestimates potential costs, because it ignores potential bans on the discharge of drilling fluids and cuttings and other wastes, and EPA estimates show that these costs can be significant.

Underground Injection Controls. In 1989, EPA reviewed its program regulating underground injection controls for Class II wells under the Safe Drinking Water Act. Class II wells are located at oil and gas production facilities and generally are used for disposal of produced waters and enhanced recovery of crude oils. EPA's review identified five program areas of concern: (1) mechanical integrity testing requirements; (2) well construction requirements; (3) review and corrective action requirements; (4) operating, monitoring, and reporting requirements; and (5) plugging and abandonment. EPA plans to propose standards for Class II wells in 1994. Using various studies (including a study by Gruy Engineering conducted for API),[93] ICF Resources estimated that possible revisions to requirements in the first three areas of concern could cost the petroleum exploration and production sector $0 to $21,683 million initially and $77 million to $529 million annually ($1988).[94] The cost estimates vary with the assumed degree of stringency of potential regulations; for example, the high initial cost estimates assume relatively stringent corrective action requirements. Annualizing at 10 percent over 20 years (by assumption), the costs range from $77 million to $3,076 million. Adjusting to $1991 yields a range of $0 to $ 24,295 million initially, $86 million to $593 million annually, and $86 million to $3,446 million in annualized costs.

Revised Effluent Standards for Refineries. Currently, petroleum refiners must comply with technology- and water quality-based control requirements for conventional, nonconventional, and toxic pollutants discharged to surface waters. EPA has established this regulatory program under Clean Water Act authority. Action initiated by EPA or Congress could more stringently regulate refinery effluents.

EPA's revised guidelines. In response to a judicial consent decree (*Natural Resources Defense Council et al. v. Reilly* (D.D.C. 89-2980) January 31, 1992), EPA is planning to review its guidelines for petroleum refinery and other industrial effluents. EPA is currently working on a preliminary study of refinery discharges to surface waters and publicly-owned

treatment works, which is expected to be completed by the end of 1993. EPA plans to propose a rule in January 1995 and finalize new guidelines in July of 1996.[95]

Legislative proposals. A bill introduced in the 102nd Congress to reauthorize the Clean Water Act, S. 1081 (Sen. Baucus, D-Mont.), could have required that EPA establish more stringent effluent limitations for refineries. In addition, a 1993 reauthorization bill (Baucus/Chafee - S. 1114) would increase controls on toxics and allow EPA to more stringently regulate conventional pollutants.

A study by Bechtel Corporation (for the National Petroleum Council) has estimated the costs to refiners of treating their wastewaters with the "best achievable technology" (BAT) in order to minimize their organic content and toxicity (as determined by acute and chronic biomonitoring). Capital costs are estimated to total $7,909 million. Annual costs rise as requirements are implemented, from $438 million to $876 million.[96] Annualized over 20 years at 10 percent (by assumption), this amounts to $1,367 million to $1,805 million.

Great Lakes Water Quality. Under authority of the Clean Water Act, EPA issued proposed water quality guidance on April 16, 1993 for all waters in the Great Lakes basin.[97] Such guidance is one means to fulfill U.S. obligations under the U.S.-Canada Great Lakes Water Quality Agreement of 1978 (as amended); the proposal also could fulfill requirements in the federal Great Lakes Critical Programs Act of 1990. EPA's proposed guidance includes uniform, minimum water quality standards, anti-degradation policies, and implementation procedures. These standards could force affected states to promulgate stricter effluent control requirements. Refineries would be the main petroleum industry sector affected, but stricter state requirements could also affect other industry sectors (such as marketing terminals, for example). It is possible that EPA's requirements could be made final in 1995.

A study by the Ohio Petroleum Council has estimated that, based on survey responses, if the proposed rule were to be put into effect, four refineries in the Great Lakes Basin would expect to incur the following costs: initial (capital) costs of $78 million to $292 million, and $36 million to $64 million in annual operating costs.[98] Annualized at 10 percent over 20 years (by assumption), this amounts to $45 million to $98 million per year. This may underestimate costs, because the refineries responding to the survey account for 83 percent of U.S. refining capacity making discharges into the Great Lakes Basin.

It is important to note that although EPA's Great Lakes initiative will only become effective in eight states, it is possible that uniform water quality standards could be implemented in other areas of the U.S. EPA has requested public comment on whether elements of its Great Lakes proposal should be considered for implementation in other regions. Elements could become effective in EPA Region IV, for example, where a similar program to improve water quality is being developed in the Gulf of Mexico. In addition, federal legislation could require additional standards for the Great Lakes or uniform regional standards in other areas. Sen. Metzenbaum (D-OH) recently introduced a bill (S. 1183) that seeks to improve Great Lakes water quality. It is also possible that Clean Water Act reauthorization could incorporate regional standards for other areas (such as the Chesapeake Bay and Boston Harbor).[99] Depending on the area or areas affected in regions other than the Great Lakes, additional refineries, production facilities, and other petroleum facilities could be affected.

4. *Spill Prevention, Response, and Compensation*

Above-ground Tank Spill Prevention. The petroleum industry utilizes approximately 700,000 above-ground storage tanks (ASTs) at its marketing, refining, transportation, and production facilities.[100] Under authorities in the Clean Water Act, as amended by the Oil Pollution Act of 1990, EPA is undertaking three regulatory efforts aimed at minimizing releases

of oil from ASTs.[101] Revisions to the SPCC program and possible requirements for secondary containment are discussed here. Response plans for AST owners and operators are discussed in the section on oil spill response plans.[102] It also is possible that AST legislation will be part of RCRA or CWA reauthorization; this also is discussed separately.

SPCC Program Revisions. Under authority of the Clean Water Act, EPA proposed a rule to amend its Spill Prevention Control and Countermeasures (SPCC) program in October 1991.[103] The SPCC program includes spill prevention procedures, methods, and equipment requirements. The proposed requirements modify the applicability of the program and the procedures for completing SPCC plans at covered facilities. The October 1991 proposed rule would apply to facilities in many industries that own above-ground tanks storing oil, including petroleum exploration and production, refining, transportation, and marketing facilities, as well as farms, coal mines, and electric utilities. EPA's preliminary data estimate the number of SPCC facilities at 505,000.[104] Since EPA's data on affected facilities is incomplete, EPA has proposed to require notification so that additional data on numbers, locations, and size of facilities can be collected. EPA expects to finalize the revised SPCC requirements early in 1994.

EPA estimated total annualized costs associated with its proposal to be $145 million. This estimate assumes a 10-year timeframe and a discount rate of 10 percent.[105] Using EPA data, it has been estimated that about half of all oil storage facilities in the U.S. that meet SPCC storage capacity requirements are operated by the petroleum industry.[106] It is thus estimated here that annualized costs to the petroleum industry of EPA's SPCC requirement revisions are $73 million.

Secondary Containment. The Oil Pollution Act of 1990 requires that a study be done on secondary containment/liners for above-ground storage tanks (ASTs). The law required that the study be completed in 1991; however, EPA has not finalized the report. Once complete, EPA's findings are to be implemented within six months; this is expected to entail a rulemaking effort on the part of EPA.

A study conducted for API by Gruy Engineering Corporation estimated the costs of secondary containment for diked areas surrounding petroleum industry above-ground tanks. This study estimated ranges of costs, depending upon whether or not ASTs not currently regulated by the SPCC program must install controls. The study estimated $4,131 million to $5,825 million in one-time (capital) costs ($1989). The study annualizes costs by petroleum industry sector (over each sector's median tank age, using an interest rate of 10 percent).[107] The annualized estimates total $435 million to $624 million per year. Conversion to $1991 yields a range of capital costs from $4,454 million to $6,280 million; annualized costs are $469 million to $673 million.

An API study in 1992 estimated that retrofitting petroleum industry ASTs themselves with liners would cost between is $12,900 million and $26,900 million."[108] Annualized over 20 years at a discount rate of 10 percent (by assumption), this amounts to $1,515 million to $3,160 million.

Summing the estimated costs for secondary containment under ASTs and for their diked areas yields a total estimated range of annualized costs of $1,984 million to $3,833 million. Actual costs incurred, however, will be highly dependent upon the stringency of final requirements.

Double Hulls on U.S. Tankers. The Oil Pollution Act of 1990 requires that tankers and barges navigating in U.S. waters be equipped with double hulls between 1995 and 2015. The U.S. Coast Guard proposed regulations in December 1990[109] and an interim final rule on August 12, 1992.[110] Final requirements are expected November 1993. The costs of both building tankers and operating them will increase as a result of the requirements. Operating costs will increase, for example, as maintenance and repair costs increase.

The most current Coast Guard cost estimate, based on the regulatory impact analysis prepared for the interim final rule, is $6.09 billion. This is a present value estimate for the period 1992 to 2015, using a discount rate of 7 percent.[111] Annualized at 7 percent over 24 years (for consistency) yields an annualized cost estimate of $531 million.

Vessel Financial Responsibility. Under authorities in the Oil Pollution Act of 1990 and the Comprehensive Environmental Response, Compensation, and Liability Act, the U.S. Coast Guard proposed financial responsibility requirements for owners and operators of vessels over 300 gross tons in September 1991.[112] This proposal requires the owners and operators to establish and maintain evidence of insurance or other methods sufficient to meet their potential liability for discharges or threatened discharges of oil or hazardous substances. A final rule could be promulgated in 1994.

A July 1993 analysis by the Coast Guard estimated that increased insurance costs due to OPA's requirements is 4.4 cents per barrel of oil shipped.[113] Multiplying this estimate by the number of barrels of oil imported into the U.S. annually (approximately 2.774 billion)[114] yields an estimate of the total annual increase in insurance costs: $122 million. This probably underestimates costs to the petroleum industry of OPA requirements, because nonimport shipments of oil are subject to the requirements as well.

The Coast Guard's analysis also examined the impacts of four regulatory options, including maintaining existing requirements, adopting the proposed rule, and adopting modified versions of the proposed rule. The analysis concludes that although the proposed rule would not in itself impose significant direct costs, severe economic disruptions could occur if certain types of financial guarantees become unavailable. A 1992 study by Mercer Management Consulting (conducted for the Coast Guard) describes potential effects if two-thirds of vessel operators were unable to meet the proposed financial responsibility requirements: ". . . some 43 percent of the nation's oil supply would be shut off. An immediate impact would be felt by the marine industry, including the potential layup of 1,400 ships and barges and unemployment for 25,000 mariners. Marine oil terminals, tank truck drivers, marine-fed refineries, and service stations would be affected next, jeopardizing more than 260,000 jobs."[115]

Oil Spill Response Plans. The Oil Pollution Act of 1990 requires that owners and operators of vessels and facilities handling oil prepare response plans; the goals of these regulations are to improve response capabilities and minimize the impacts of oil spills. Responsibility for implementing these requirements was divided among a number of agencies in Executive Order 12777, according to the type of facility to be regulated. All agencies had statutory deadlines for issuing requirements by August 18, 1992, with facility deadlines of February 18, 1993 for plan submissions. Facilities classified as representing "significant and substantial harm" were to have their response plans approved by August 18, 1993. No agency met the regulatory deadline of February 1993, although by the end of 1992 the U.S. Coast Guard was furthest along, having issued guidance for response plans in September 1992. Agencies have since either proposed rules or issued interim final rules.

All sectors of the petroleum industry are affected by response plan requirements outlined in the Oil Pollution Act. Facilities that do not comply with requirements by their effective dates are prohibited from handling, storing, or transporting oil. Significant capital (e.g., equipment) and operating costs will be incurred with respect to vessel response capabilities. Compliance costs incurred in the writing of response plans for facilities are expected to be significant as well, as outside contractors are generally required. Additional costs may be incurred as well, as petroleum companies have tended to write their response plans according to the Coast Guard guidelines, and thus if requirements stemming from other agencies are different, such plans will need to be rewritten. The oil spill response plan requirements that are expected to

be most costly to the petroleum industry are discussed below.

Vessels. The U.S. Coast Guard issued guidance on vessel response plans in September 1992[116] and an interim final rule on February 5, 1993.[117] The interim final rule covers vessels that carry oil in bulk as cargo, and certain vessels operating in Prince William Sound, Alaska. The Coast Guard plans to finalize these requirements early in 1994. Mercer Management Consulting estimated (for the Coast Guard) that the present value of total compliance costs would be $2.7 billion.[118] Included in this estimate are capital and operating expenses for shore-based response capability, such as that provided by the Marine Spill Response Corporation (MSRC), the National Response Corporation, and regional co-operatives.[119] Although some non-petroleum industry vessels (e.g., fishing vessels) are covered by the interim rule, the number of these vessels is thought to be very small;[120] it is therefore reasonable to attribute all estimated costs to the petroleum industry. Using a discount rate of 7 percent, Mercer Management Consulting calculated total annualized costs for various years; these vary from $318 million in 1992 to $184 million in 1995, $217 million in 2000, and $227 million in 2015.[121] For this analysis, a range in annualized costs of $184 million to $318 million is used.

Marine Transportation-Related Facilities. The U.S. Coast Guard issued guidance in September 1992[122] and an interim final rule February 5, 1993.[123] A final rule is expected early in 1994. The interim final rule covers facilities that handle, store, or transport oil in bulk, such as deepwater ports, marinas, tank trucks, and railroad tank cars. The Coast Guard estimated costs to be $43.7 million on an annualized basis (10 years, 10 percent).[124] In addition, costs associated with facilities operating in Prince William Sound, Alaska were estimated to be $232 million for the 10-year period 1993-2002.[125] Assuming that this is a present value, annualized costs (discounted over the 10 years at 10 percent) are $37.8 million. Adding estimated annualized costs together yields a total estimated cost of $81.5 million.

Facilities with Above-ground Storage Tanks. OPA response plan requirements, once finalized, will elicit additional planning by some facilities covered by EPA's SPCC program; some facilities not presently covered by the SPCC program will also be required to develop spill response plans. EPA proposed a rule in February 1993.[126] Affected facilities are those that either (1) store more than 1 million gallons of petroleum and meet other criteria, or (2) store more than 42,000 gallons of oil and transfer oil over water or by vessel. The rule also puts forth other technical requirements. EPA expects to finalize this rule early in 1994.

EPA estimated total costs associated with the proposed rule as follows: initial costs of $140.6 million, annual costs of $60.9 million, and annualized costs of $73.2 million. Costs are annualized over 10 years, assuming a discount rate of 10 percent.[127] Based on EPA's SPCC data, it is estimated that petroleum industry facilities account for about 86 percent of facilities with AST oil storage capacity of 42,001 gallons or more.[128] Using this share to allocate spill response plan costs to the petroleum industry yields estimated initial, annual, and annualized costs of $121 million, $52 million, and $63 million, respectively. These estimates could over- or understate actual petroleum industry response plan costs, since, for example, the petroleum industry could comprise more or less than 86 percent of affected facilities.

Onshore Oil Pipelines. Early in 1993 the Research and Special Programs Administration (of DOT) issued an interim final rule for onshore oil pipelines.[129] Oil pipeline operators were required to submit response plans by February 18, 1993. Very small pipelines and pipelines located far from navigable waters are exempt. RSPA expected to receive approximately 5,000 response plans[130] and estimated costs for small, medium, and large facilities. Initial (first-year costs, which include response capability) are estimated to range from $33,470 to $168,222 per facility; subsequent year costs (which include response capability) are estimated to range

from $28,432 to $141,206 per facility.[131] Classifying response capability costs as annual costs and multiplying the resulting ranges by 5,000 yields the following estimated total costs: initial costs of $167 million to $841 million, annual costs of $142 million to $706 million. Annualizing these costs (at 10 percent over 10 years, for consistency with other response plan cost estimates) yields estimated annualized costs of $169 million to $843 million. RSPA expects to finalize response plan requirements for oil pipelines early in 1994.

Discharge Removal Equipment for Vessels Carrying Oil. Under authorities in the Oil Pollution Act of 1990, the U.S. Coast Guard proposed requirements for vessels carrying oil in bulk (as cargo) in September 1992.[132] These proposed requirements cover (1) the carrying of equipment to contain and remove on-deck spills, (2) the installation of spill prevention coamings, and (3) the installation of emergency towing arrangements. The Coast Guard estimated total present value costs of the proposed rule to be $174 million; it estimated total annualized costs of $18 million.[133]

In the summer of 1993 the Coast Guard was authorized to delay the rulemaking process in order to undertake a study of equipment safety and economic feasibility. A final decision on requirements is planned for 1995, at the earliest.

5. *Multimedia*

Expansion of Toxic Release Reporting. Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) requires that some manufacturers (including petroleum refiners) report their annual emissions of certain chemicals and chemical compounds to land, air, and water by July 1st each year. EPA makes reported data available to the public through the Toxic Chemical Release Inventory (TRI). The reporting form is known as "Form R." The data can be used to measure progress in pollution prevention, and it is believed that the public nature of these data works as an incentive for reporting firms to prevent pollution. Several factors indicate that expanded reporting of additional chemicals or information types, or reporting by additional industries, may be required in the future.

Legislative proposals. Recent Congressional bills have proposed expansion of TRI reporting. For example, H.R. 2880, introduced by Rep. Sikorski (D-Minn.) in 1991, would expand reporting to the exploration and production sector of the petroleum industry and to service stations. This proposed legislation would also add more than 600 chemicals to the reporting list.

Actions by EPA. EPA has announced its intention to expand the TRI in 1993 and 1994 by adding about 200 more chemicals and requiring additional industries to report;[134] this authority is provided by EPCRA. EPA actions to expand toxic release reporting may also be prompted in response to other laws and petitions. Two such actions are particularly relevant. (1) The Pollution Prevention Act of 1990 requires that Form R must include information on source reduction and recycling activities. Firms submitting Form Rs in 1992 and 1993 are expected to comply with the provisions of the Pollution Prevention Act, although EPA has not yet finalized its modifications to Form R. Although EPA has proposed a rule,[135] it is expected that Form R will not be finalized until 1994.[136] (2) EPA must consider petitions from the public requesting that chemicals be added to or deleted from the TRI list. For example, in response to a petition from Governor Mario Cuomo of New York and the Natural Resources Defense Council, EPA has proposed to add 68 chemicals and 2 chemical categories to the list of toxic chemicals subject to reporting under Section 313.[137] In addition, as part of its 1993 expansion of the TRI chemicals list, EPA is considering adding 5 chemicals requested for listing by several environmental groups.[138]

Expansion of reporting to marketing operations and/or the exploration and production sector could be required in legislation or in EPA decisions. Dames & Moore has recently estimated (for API) the costs of

expanding TRI reporting to exploration and production facilities. This study estimated first year costs of $211 million, annual costs of $133 million, and annualized costs of $170 million.[139] Annualized costs were calculated using a discount rate of 12 percent, over 10 years.[140] These figures could understate potential costs to the petroleum industry, since they do not include potential new costs to refiners or service station owners or operators.

B. Highly Uncertain Requirements for Which Cost Estimates are Available

Compliance cost estimates have been made for several highly uncertain, potential environmental requirements (see Table 2). The high degree of uncertainty as to the exact nature of requirements or whether they will in fact be put into place preclude them from being listed along with the more certain requirements discussed in the previous section. Further, as is noted in the discussion of some of these potential requirements, some of the cost estimates presented may partially double-count costs estimates presented in Section A.

1. *Air*

Clean Air Act Amendments of 1990: Air Toxics -- Residual Risk Requirements. As mentioned above, the air toxics program in Title III of the Clean Air Act Amendments is to be implemented in two phases: the initial MACT standards and subsequent possible "residual risk" requirements. The second phase, which may more stringently regulate facilities, may be put into effect eight or more years after the MACT standards are promulgated. It is uncertain at present whether EPA will determine that residual risk controls will be necessary for petroleum sources.

A study conducted for API in 1989 and updated early in 1990 (i.e., before the Clean Air Act Amendments were finalized) outlined possible residual risk requirements for the petroleum industry.[141] As was done for potential MACT requirements, a recent analysis by API estimates ranges of potential residual risk compliance costs, based on assumed levels of regulatory stringency and the cost estimates derived in the 1990 study.[142] To reflect the possibility that MACT requirements alone will prove sufficient in controlling pollutants, cost assumptions are structured to yield $0 as the low estimate for total potential residual risk requirements. Cost estimates based on the revised analysis are as follows: $0 to $5,671 million for initial capital, $0 to $700 million in annual costs, and annualized costs of $0 to $1,492 million. The assumed discount rate of 10 percent was retained; various types of required equipment were assumed to last different lengths of time.

It should be noted that, due to the fact that some potential requirements could take effect under either EPA's MACT or residual risk program, some of the costs estimated here are also counted in with the cost estimates presented above for MACT requirements.

Clean Air Act Amendments of 1990: Air Toxics -- Phase Out of Hydrogen Fluoride. EPA has undertaken a study, as mandated by the Amendments,[143] on ways to reduce hazards associated with industrial use of hydrogen fluoride (HF). EPA is planning to release its report at the end of September 1993.[144] The study could recommend that new legislation be passed either to increase controls on HF use or to ban its use entirely. The report could also recommend that no legislative changes be made.

Some petroleum refineries use HF in alkylation processes that increase octane levels in unleaded gasoline. In a study for the National Petroleum Council, Bechtel Corporation has estimated the costs to refiners of replacing HF alkylation units in refineries with sulfuric acid alkylation units. Estimated costs total $3,142 million for capital and one-time expenses. Annual costs rise as requirements are implemented, from $214 million to $427 million.[145] Annualizing at 10 percent over 20 years (by assumption) yields annualized costs of $583 million to $796 million. Actual costs could be much lower,

Table 2.

Highly Uncertain Potential Federal Environmental Requirements for the Petroleum Industry for Which Potential Cost Estimates are Available

Requirement Domain/Requirement	Estimated Initial Costs ($ mil)	Estimated Annual Costs ($ mil)	Estimated Annualized Costs ($ mil)	Cost Estimate Source(s)
Air				
Clean Air Act Amendments of 1990:				
Air Toxics -- Residual Risk Requirements	0 - 5,671	0 - 700	0 - 1,492	API
Phase Out of Hydrogen Fluoride	3,142	214 - 427	583 - 796	Bechtel/NPC
Waste				
'RCRA Reauthorization Legislation:				
Exploration and Production Wastes	4,438 - 56,447	1,494 - 3,302	2,015 - 9,932	ICF (for DOE) and Gruy (for API)
Surface Impoundments at Refineries	3,377 - 5,483	117 - 190	475 - 772	API
Water				
Clean Water Act Reauthorization:				
Stormwater Control	3,178	40 - 138	413 - 511	Bechtel/NPC
Effluent Fees	NA	32	32	CRS
Spill Prevention, Response, and Compensation				
Above-ground Tank Legislation	9,159 - 12,634	270 - 440	1,252 - 1,820	Gruy (for API)

Note: Estimates are in 1991 dollars.
Initial costs of some requirements are annualized differently than others. See the text for explanations of how each was calculated.

however, if EPA recommends and Congress adopts few or no further controls on HF. However, if HF standards are set very strict or if HF is banned altogether, this could influence how other chemical compounds used by the petroleum industry are regulated, particularly by new accidental release prevention requirements.

2. *Waste*

RCRA Reauthorization Legislation: Exploration and Production Wastes. Bills related to RCRA reauthorization are expected to be considered in the 103rd Congress; several proposals on the regulation of exploration and production wastes have been introduced or discussed in recent years. For example, in the 102nd Congress, Rep. Swift (D-Wash.), who introduced a RCRA reauthorization bill in 1991 (H.R. 3865), also intended to propose legislation on oil and gas wastes.[146] Legislation could greatly increase the stringency of management standards for wastes and waste management units at oil and gas exploration and production facilities. More specifically, standards similar to RCRA's Subtitle D regulations may be developed.

Using numerous studies (some of them by or for API), ICF Resources has estimated (for DOE) the following costs of potential requirements for drilling muds and cuttings, associated wastes, emergency pits, workover pits, and corrective actions: initial costs of $3,961 million to $21,669 million and annual costs of $1,333 million to $2,892 million ($1988).[147] ICF's cost estimates vary with assumed degrees of stringency of potential requirements. Converting the cost estimates to $1991 yields an initial cost range of $4,438 million to $24,279 million and an annual cost range of $1,494 million to $3,240 million.

Gruy Engineering Corporation recently completed an economic study of potential Subtitle D-type regulations (for API), based on the Subtitle D requirements for industrial facilities proposed in 1991 in S. 976. Gruy estimates that if all exploration and production facilities continue operating, initial compliance costs would total $56,447 million, and annual compliance costs would total $3,302 million.[148] It is unlikely that payments of these magnitudes would actually be made, because, as the Gruy study found, significant closures of wells and losses of reserves would in fact result from such regulations.

Thus, the cost estimates available for potential requirements on exploration and production wastes vary substantially, depending on assumptions about the stringency of potential requirements. Annualizing the ICF and Gruy estimates (separately) at 10 percent over 20 years (by assumption), a cost range of $2,015 million (ICF) to $9,932 million (Gruy) is calculated.

RCRA Reauthorization Legislation: Surface Impoundments at Refineries. Petroleum refiners use surface impoundments to manage stormwater, flow equalization, and biological treatment. Currently, refiners that use hazardous waste surface impoundments, which are regulated under Subtitle C of RCRA, are required to have double liners, leachate collection systems, and groundwater monitoring systems. It is possible that RCRA reauthorization could include new management standards for nonhazardous surface impoundments; such standards could include elements as required under Subtitle C. For example, a bill proposed by Sen. Baucus in 1991 (S. 976) addressed Subtitle D facilities such as surface impoundments, and environmental threats potentially posed by surface impoundments have been discussed at Senate hearings on RCRA reauthorization.[149]

A recent study by API estimated potential costs to refiners (depending on the stringency of surface impoundment requirements) as follows: initial costs: $3,377 million to $5,483 million, annual costs: $117 million to $190 million, and annualized costs: $475 million to $772 million.[150] Annualized costs assume a time horizon of 30 years and are calculated using a discount rate of 10 percent.

It should be noted that there could be some overlap between the costs estimated here and those

estimated above for modifications to land disposal restrictions promulgated in 1990.

3. *Water*

Clean Water Act Reauthorization: Stormwater Control. EPA has a new permit program regulating stormwater management (see separate discussion); further requirements could be part of CWA reauthorization. New stormwater requirements could increase or limit requirements for petroleum refineries, exploration and production operations, and/or service stations. For example, S. 1114 by Sens. Baucus (D-Mont.) and Chafee (R-RI) could require permits from some service stations.

In a study for the National Petroleum Council, Bechtel Corporation has estimated the costs to refiners of some measures to further control their stormwaters. Total costs associated with (a) reducing oil to sewers (using closed loop samplers), (b) reducing runoff from unpaved process areas, (c) controlling stormwater quality, (d) raising or replacing below-grade process piping, and (e) installing hard pipe tank drawoff equipment are estimated to total $3,178 million for capital. Annual costs rise as requirements are implemented, from $40 million to $138 million.[151] Annualized over 20 years at 10 percent (by assumption) yields annualized costs of $413 million to $511 million.

Clean Water Act Reauthorization: Effluent Fees. Several Congressional bills have proposed effluent fees on discharges. In the 102nd Congress, for example, S. 1081 (Sen. Baucus, D-Mont.) proposed such fees. More recently, Rep. Studds (D-Mass.) introduced a bill in May 1993 (H.R. 2199) that would tax industrial chemical discharges to surface waters and publicly-owned treatment plants. A study by the Congressional Research Service has estimated that such fees from petroleum refiners could total $32 million per year.[152]

4. *Spill Prevention, Response, and Compensation*

Above-ground Tank Legislation. Legislation to further regulate above-ground tanks (ASTs) in order to prevent future spills of petroleum could become part of RCRA or CWA reauthorization. Several bills have recently been introduced in Congress. For example, a bill by Thomas Daschle (D-SD), S. 389, would require release-detections systems, inspections, secondary containment, and corrective action plans for ASTs.[153] Bills by Sen. Robb (D-VA) and Rep. Moran (D-VA), S. 588 and H.R. 1360, would require, among other things, notification, release detection systems, certified inspections, corrosion protection, and performance standards. In contrast to the Daschle bill, the Robb/Moran bill would exclude ASTs at production facilities from many provisions.

A study conducted for API in 1990 examined the costs of potential certification, secondary containment, and technical standards, as well as an expanded scope of SPCC requirements to ASTs currently exempt from the program.[154] This study estimated ranges of costs, depending upon whether or not ASTs not currently regulated by the SPCC program must install controls. This study estimated that one-time (i.e., capital) costs (excluding those for secondary containment, which are discussed elsewhere in this paper) to all sectors of the petroleum industry could total $8,495 million to $11,722 million, while annual costs could total $250 million to $408 million.[155] Total annualized costs of $1,161 million to $1,688 million ($1989) are calculated, using an interest rate of 10 percent per year. The study annualizes costs by petroleum industry sector, over each sector's median tank age. Updating the annualized estimates to $1991 yields estimated potential annualized costs of $1,252 million to $1,820 million. (In $1991, initial costs are $9,159 million to $12,634 million, and annual costs are $270 million to $440 million.)

C. Requirements for Which Little or No Cost Information is Available

Compliance cost estimates for the petroleum industry are not presently available for many new or potential federal environmental requirements. Table 3 lists the requirements that could be most costly to the industry.

1. *Air*

Fuel Requirements for Fleets. Recent legislation seeks to encourage the use of alternative fuels (fuels that are "substantially not petroleum," including methanol, LPG, and natural gas) and replacement fuels (the non-petroleum portion of motor fuel, e.g., the oxygenate portion of reformulated gasoline) by requiring their use by vehicle fleets such as taxis or delivery vans. Such fleet mandates may be costly, as alternative and replacement fuels tend to cost more than gasoline.[156] In addition, these requirements can impose indirect costs on the petroleum industry associated with reconfiguring refineries and distribution systems in response to changes in fuel market shares.

Energy Policy Act of 1992. This Act requires that, among other things, DOE must establish state and private fleet programs for increased use of alternative fuels. The Act also includes provisions for a federal fleet program. In addition, DOE also must study the feasibility of achieving a replacement fuel goal of 10 percent of projected motor fuel use by the year 2000 and 30 percent by the year 2010.

Clean Air Act Amendments of 1990. The Amendments require that, through revised state programs, exhaust emission standards must be tightened for new car and truck fleets (beginning in 1998) in certain ozone and carbon monoxide nonattainment areas. Fleet operators can comply with the new standards by purchasing, converting, or acquiring credits for a certain percentage of their vehicles. For example, in 1998, 30 percent of new cars and light trucks in affected fleets must run on "clean alternative fuel." (Unlike the Energy Policy Act's definitions of alternative and replacement fuels, the Clean Air Act's definition of "clean alternative fuel" specifically includes reformulated gasoline.) By 2000, 70 percent of these vehicles must meet the standards. EPA also intends to provide incentives for fleets to purchase "ultraclean" vehicles fueled with natural gas, propane, pure alcohol, or electricity.[157] EPA has begun implementing this plan; a final rule governing the credit program for clean fuel fleets was issued in March 1993,[158] and a rule governing emission and other standards was proposed in June 1993.[159]

Fuels and Fuel Additives/Section 211 Test Rule. The Clean Air Act requires that EPA establish a testing program as part of the registration process for fuels and fuel additives. The Act also provides EPA with the authority to prohibit the manufacture or sale of such products that may endanger public health. EPA proposed a rulemaking on fuel and fuel additive testing and research in April 1992.[160] EPA has a court-ordered deadline for issuing a final rule by October 1993, but is likely to request an extension until well into 1994.

The potential costs of a test rule to the petroleum industry could be high, but they cannot be estimated until the scope of the program becomes clearer. Costs could be significant if EPA were to require testing for each fuel and additive. This is because individual tests can be expensive. For example, API has incurred biological assay testing costs totaling more than $1 million for a single compound.[161] One method (proposed by EPA) for lowering testing costs would be to allow manufacturers to test representative compounds from groupings of similar fuels or additives.

The way in which EPA implements the program also could be very costly. The least expensive approach would minimize disruption to motor fuels markets and harmonize EPA's various testing programs.

Table 3.

New and Potential Federal Environmental Requirements for the Petroleum Industry for Which Little or No Cost Information is Available, by Requirement Domain

Air

- Fuel Requirements for Fleets
- Fuels and Fuel Additives/Section 211 Test Rule
- Clean Air Act Amendments of 1990: Detergent Additives to Gasoline
- Revised RVP Test Method for Gasoline and Alcohol Blends
- Clean Air Act Amendments of 1990: Air Toxics -- Accidental Releases
- Air Toxics -- Phase Out of Halons
- Global Climate Change

Waste

- RCRA Reauthorization Legislation: Nonhazardous Waste Management, Incineration, and Interstate Transport of Waste
- Groundwater Protection/ Corrective Action Legislation
- Used Oil
- Land Disposal Restrictions for Wastes Newly-Classified as Hazardous -- TC Waste and Contaminated Soil
- Hazardous Waste Identification Rule
- Hazardous Waste Listing
- Air Emissions from Treatment, Storage, and Disposal Facilities
- New Oil and Grease Test for NPDES Permits
- RCRA Definition of Wastewater Treatment Tank
- Superfund Reauthorization
- NORM

Water

- Stormwater Permits
- Class V Injection Wells
- Sediment Analysis and Remediation
- Legislation to Prevent Offshore Leasing
- Clean Water Act Reauthorization Legislation: Wetlands and Effluent Standards for Sectors other than Refining

Spill Prevention, Response, and Compensation

- Design Standards for Tank Cars
- Financial Responsibility for Offshore Facilities
- Natural Resource Damage Assessments

Multimedia

- Pollution Prevention Directives
- Pollution Prevention Plan Legislation
- EPA Update of Potency Factors for Toxic Pollutants
- Reauthorization of the Endangered Species Act

Clean Air Act Amendments of 1990: Detergent Additives to Gasoline. As directed by the Amendments, EPA must require that, beginning in 1995, all gasolines contain detergent additives to prevent the accumulation of deposits in engines or fuel supply systems. Controlling such deposits is expected to significantly reduce emissions of pollutants. EPA plans to propose a rule late in 1993 and finalize the rule in October 1994. This regulation may or may not be costly to the petroleum industry. EPA estimates that, by 1995, even without the detergent additives rule, only 10 to 25 percent of gasoline would not contain detergent additives.[162] If EPA crafts its rule so that gasoline with additives must meet performance criteria, the rule may not be very costly to implement. However, if EPA specifies changes in the way gasoline is produced or specifies particular ways in which detergents must be added, refiners may have to make significant investments in new equipment, and costs could be significant.

Revised RVP Test Method for Gasoline and Alcohol Blends. Under Clean Air Act authority, in March 1993 EPA promulgated revisions to its regulations for RVP in gasoline and alcohol blends.[163] The revisions, which took effect in April 1993, changed the test method for determining RVP. API has filed a petition for judicial review in the D.C. Circuit[164] and plans to file a petition for rulemaking with EPA as well. Central to both petitions is the fact that the new rule's reliance on the Digital Herzog test method as the baseline method yields RVP test results about 0.13 psi higher than the conventional Dry Manual method, which for years has been the baseline for industry and regulators.

If the revised test method for determining RVP is not amended, refiners will have to produce lower RVP gasoline to meet unchanged RVP requirements. Thus, actual costs of complying with EPA's Phase II RVP reduction standards (discussed separately) would be significantly higher than estimated. Further, the revised test method could have impacts on the new reformulated gasoline program, especially when year 2000 requirements come into effect. In the year 2000 the required VOC reductions will be especially severe; if all practicable RVP reductions have been made, the 0.13 psi bias associated with the present test method could require that fuel sulfur be reduced, and such reductions would be costly.

Clean Air Act Amendments of 1990: Air Toxics -- Accidental Releases. Title III of the Amendments includes provisions to limit accidental releases of the most hazardous pollutants to air and to improve response capabilities if releases do occur. EPA is required to promulgate standards by November 1993, with the standards due to take effect three years later. As required by the Amendments, EPA has proposed a list of Extremely Hazardous Air Pollutants (EHAPs).[165] EPA also is required to establish release prevention, detection, and correction requirements. Facilities must assess potential hazards and establish prevention and control programs for each EHAP they manufacture, use, or otherwise handle in quantities above threshold levels (to be set by EPA).

Based on the proposed rule, petroleum refineries and exploration and production facilities will be subject to EPA's accidental release requirements; terminals and pipelines are also potentially covered. EPA has estimated that an average facility (including nonpetroleum facilities) will spend between $10,000 and $250,000 to comply with risk management plan requirements. EPA has stated, however, that costs for petrochemical facilities could be much higher.[166]

It is important to note that the regulation of hydrogen fluoride (discussed separately) could influence how chemical compounds used by the petroleum industry are regulated in accidental release prevention requirements.

Clean Air Act Amendments of 1990: Air Toxics -- Phase Out of Halons. Both the 1992 Montreal Protocol on Substances that Deplete the Ozone Layer and Title VI of the Clean Air Act Amendments require the phase-out of production of chlorofluorocarbons (CFCs), which may contribute to global climate change. Production of halons, which

are typically used for fire fighting and explosion protection, is to be phased-out by the end of December 1993 under the Montreal Protocol. However, halons are among the Clean Air Act Amendments' "Class I" substances, which are scheduled for phase-out by the year 2000. EPA is allowed to grant "essential use" exemptions until the year 2000, under the Amendments. EPA has requested nominations for such exemptions for halons.[167]

Petroleum refineries and oil and gas facilities use fire fighting and explosion protection agents that contain halons. Since no good substitutes exist at present, phase-out could result in significant expenditures by the petroleum industry. For example, although stockpiled supplies of halons may be bought after December 1993, these supplies might be sold at increased prices.

Global Climate Change. In accordance with both federal legislation and international efforts, the U.S. government is seeking to limit possible impacts of "greenhouse" gases in the atmosphere. The Energy Policy Act of 1992 contains a number of requirements to control global climate change. Among these requirements are energy efficiency standards for various types of industrial equipment, research and development on fuels and vehicles that reduce carbon emissions, establishment of voluntary reporting programs on greenhouse gas emissions, and studies leading to alternative schemes for reducing carbon emissions. On April 21, 1993 President Clinton announced his commitment to lower U.S. emissions of greenhouse gases to 1990 levels by the year 2000. Federal agencies are drafting specific strategies, and the White House plans to announce a set of options in 1993. In addition, the U.S., as a signatory to the United Nations Framework Convention on Climate Change, is required to develop a national plan for "limiting its anthropogenic emissions of greenhouse gases" after the Convention enters into force. So far, 31 of the required 50 countries have ratified the Rio Convention, and the Convention is generally expected to enter into force in early 1994.

The petroleum industry could be affected through any of three most likely federal policy choices: taxes, stringent energy efficiency standards, or "voluntary actions." Taxes could be levied on petroleum products according to their Btu or carbon-content levels. Energy efficiency standards could revise existing fuel efficiency requirements for automobiles or establish strict standards for industrial equipment. "Voluntary actions" could involve additional reporting, increased conservation, or fuel switching (to fuels with lower emissions of greenhouse gases when burned). A tax would affect the petroleum industry directly, while the other policy choices could affect the petroleum industry more indirectly.

2. *Waste*

RCRA Reauthorization Legislation: Nonhazardous Waste Management, Incineration, and Interstate Transport of Waste. Several issues other than exploration and production wastes, used oil, and groundwater protection that may be covered by RCRA reauthorization are of interest to the petroleum industry.

Interstate Transport of Waste. For example, two bills (H.R. 105 (Rep. Applegate, D-Ohio) and H.R. 599 (Rep. Kanjorski, D-Pennsylvania)) would ban interstate transport of solid waste or allow restrictions on such transport.

Incineration. A bill by Rep. Towns (D-NY), H.R. 424, would put new restrictions on solid and hazardous waste incinerators.

Nonhazardous Waste Management. Potential new requirements under Subtitle D of RCRA could affect waste management in units such as surface impoundments and landfills, which are used by the petroleum industry (surface impoundments at refineries are discussed elsewhere in this paper). In the 102nd Congress, S. 976 (mentioned above) contained Subtitle D industrial requirements. Rep. Swift (D-Wash.), who

introduced a RCRA reauthorization bill in 1991 (H.R. 3865), intended also to propose legislation on industrial nonhazardous waste.[168]

Groundwater Protection/Corrective Action Legislation. Legislation expressly seeking increased protection of groundwater could be part of reauthorization efforts for either the Clean Water Act or RCRA. Such legislation could overlap with established and potential RCRA requirements (e.g., corrective action requirements), since an important aim of RCRA is to prevent groundwater contamination. Recent Congressional activities focusing on groundwater protection have sought to influence the location of waste management units and the stringency of cleanup programs.

Location of waste management units. A bill introduced by Rep. Gallo (R-NJ) in the 102nd Congress, H.R. 688, would ban the siting of solid waste management units in certain areas.

Stringency of cleanup programs. Sen. Baucus's 102nd Congress RCRA reauthorization bill, S. 976, as amended, contained a policy statement regarding the protection of groundwater. According to EPA, the policy statement, if adopted, could significantly affect federal cleanup programs, including RCRA corrective action, underground storage tank remediation, and Superfund. EPA estimated that annualized national costs of the policy statement could total $1.7 billion to $5.7 billion.[169]

A recent study conducted for API examined potential corrective action costs for a hypothetical large, complex petroleum refinery. Based on this study, it is estimated that initial (capital) costs for the hypothetical refinery could be $163 million more than potential compliance costs associated with EPA's proposed corrective action rule. Annual operating costs associated with corrective actions could increase by about $400,000.[170]

Used Oil. Under authority of RCRA, in 1992 EPA promulgated final rules regulating the management, disposal, and recycling of used oil.[171] As published in these rules, EPA decided not to list used oils to be disposed of or recycled as hazardous waste. EPA's decision on not to list used oil to be disposed of took effect in June 1992. The management standards were to take effect in March 1993; however, effectiveness in some states may be delayed to 1994 or 1995, depending upon state implementation.

Several lawsuits currently pending could clarify or change the stringency of EPA's rules.[172] If used oils are reclassified as hazardous or if management standards are interpreted very stringently, the refining and/or exploration and production sectors of the industry could incur higher compliance costs. For example, if management standards were to apply to used oils inserted into materials processed during refining operations, refiners could incur significant compliance costs.

It should also be noted that at least one bill governing used oil has been introduced in Congress this year (H.R. 131, by Rep. Collins, D-IL). This bill would list as a hazardous waste used oil that does not meet certain specifications; the used oils at petroleum refining or production facilities would be exempt, providing the oil is inserted into the refining process. The bill also seeks to develop used oil collection centers and would require a credit system in order to encourage used oil collection.

Land Disposal Restrictions for Wastes Newly-Classified as Hazardous -- TC Waste and Contaminated Soil. In September 1993 EPA proposed a rulemaking (under authority of RCRA) on treatment standards (i.e., constituent concentration levels) for some wastes failing the new toxicity characteristic test, for soil contaminated by TC waste, and other newly-identified hazardous wastes, based on Best Demonstrated Available Technology.[173] In addition, EPA proposed "universal treatment standards" for a wide range of hazardous constituents that would, if promulgated, eventually apply to virtually all hazardous wastes, whether characteristic or listed (potentially including all listed petroleum refining

wastes). This rule is scheduled to be finalized by July 31, 1994. All sectors of the petroleum industry potentially could be affected by these land disposal restrictions once they are finalized. Costs resulting from these restrictions could be significant, due to the amounts of waste affected and the relatively high costs of some waste management techniques that would be used for compliance (e.g., off-site incineration can cost $1,700 per ton).[174] High compliance costs are especially likely for wastes failing the toxicity characteristic test.

Hazardous Waste Identification Rule. In response to a 1991 court decision,[175] EPA (in consultation with a federal advisory committee) is revising RCRA "mixture" and "derived from" rules, which address when listed hazardous wastes that are mixed with other wastes (or otherwise managed) are determined to no longer be hazardous. The agency has the option of revising the ways various types of wastes are classified as hazardous or nonhazardous, including listed hazardous wastes, waste mixtures, derivatives, and media (including soils and ground-water) contaminated with listed wastes. The agency also has the option to exempt wastes from classification as hazardous that have very low concentrations of hazardous constituents.[176]

Within this framework, EPA could revise the rules so that compliance is less costly. EPA has stated that the current regulatory system has "resulted in unnecessarily stringent requirements for certain low risk wastes."[177] EPA proposed a number of possible new regulatory approaches in May 1992, but it withdrew its proposal the following October.[178] EPA now plans to repropose requirements late in 1993 and finalize them in October 1994.[179] Depending on how they are specified, EPA's final revised regulations could significantly lower current hazardous waste management costs for the petroleum industry. The May 20, 1992 proposed rule estimated cost savings for four regulatory options; depending on waste volumes and regulatory method, national savings of $62 million to $1,820 million per year were estimated.[180]

Hazardous Waste Listing. A proposed, partial settlement of an Environmental Defense Fund suit against EPA (in June 1991) resulted in EPA's agreeing to consider listing 14 petroleum refinery residual streams as hazardous. EPA plans to propose decisions in 1995 and finalize them in 1996. In addition, EPA must issue a study in 1996 on the appropriateness of listing an additional 15 refinery residual streams. Such listings could be very costly; EPA has stated, "Depending on the number of listed wastes and their generation quantities, the costs of this action could be very significant."[181] Actual costs also will depend upon how EPA finalizes other rules affecting waste management; for example, the hazardous waste identification rule could exempt some wastes generated below "de minimis" levels.

Air Emissions from Treatment, Storage, and Disposal Facilities. Under authority of RCRA, EPA proposed regulations on July 22, 1991 to control air emissions from surface impoundments and tanks that handle hazardous wastes.[182] Certain surface impoundments may meet the requirements by installing floating synthetic covers; other surface impoundments must be covered by air-supported or rigid structures. Pretreatment of wastes (to lower potential emissions prior to management in surface impoundments) is another compliance alternative. Petroleum refineries would be subject to the requirements; the requirements also could affect marketing facilities. The rule could be very costly to facilities which do not have to comply with benzene NESHAPS requirements. Quantifying potential costs is, however, very difficult. EPA could finalize this rule in 1993. EPA also plans to examine residual risks following final rule promulgation; additional standards or guidance could be issued.

New Oil and Grease Test for NPDES Permits. Currently, EPA-required methods for testing for the oil and grease content of wastes and wastewaters involve the use of freon, a chlorofluorocarbon. Under authority in the Clean Air Act and in order to comply with the Montreal Protocol on Substances that Deplete the Ozone Layer, in July 1991 EPA proposed

alternative solvents for use in oil and grease tests.[183] EPA later rescinded its proposed rule, however, based on public comments. The use of alternative solvents can yield higher content estimates in oil and grease tests. An EPA decision to ban the use of freon in waste and wastewater testing while leaving oil and grease limits unchanged could result in significant increased costs for the refining, exploration and production, and transportation sectors of the petroleum industry, since they would, in effect, be required to treat their wastes and wastewaters to lower oil and grease contents.

RCRA Definition of Wastewater Treatment Tank. On June 22, 1992, API filed an administrative petition with EPA seeking a reconsideration or clarification of the RCRA program's definition of a wastewater treatment tank.[184] Wastewater treatment tanks are exempt from regulation under RCRA. EPA currently interprets the definition of such tanks stringently; certain treatment units that might be considered tanks (e.g., certain sewers and oil/water separators) are classified as surface impoundments, which are subject to regulation under RCRA. EPA has not enforced its interpretation. If EPA were to enforce its interpretation, compliance costs could be significant for the petroleum industry. Refineries would probably incur the highest costs, while marketing and other sectors could also be affected. Facilities using affected units would have three main options: (1) stop using the treatment unit until it is permitted under RCRA, (2) upgrade the unit until it meets requirements for a tank, or (3) stop using the unit and restructure the wastewater treatment system. Additional costs would be incurred if EPA were to enforce its definition retroactively.

Superfund Reauthorization. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) "Superfund" program, which covers the cleanup of hazardous waste sites (often abandoned sites) will be due for reauthorization in 1994; the funding program will be due for reauthorization in 1995. Deliberations in Congress have already begun. Reauthorization issues of concern to the petroleum industry can be broadly categorized into two groups: liability and funding issues, and programmatic issues.

Liability and funding issues. Currently, Superfund cleanups are financed by both private expenditures (determined by liabilities of potentially responsible parties) and taxes, which fund the national Trust Fund. Various changes in the present CERCLA liability and funding system could be considered during reauthorization. For example, municipalities could be granted full or partial exemptions from Superfund liability (as in, e.g., bills recently introduced by Sen. Lautenberg (D-NJ) and Rep. Torricielli (D-NJ), S. 343 and H.R. 870). Such changes could have significant impacts on total Superfund expenditures of petroleum companies. Petroleum companies pay shares of site cleanup costs directly; they also pay approximately 50 to 60 percent of Superfund taxes, although it appears that the petroleum industry is responsible for only a very small portion of contamination at sites cleaned up using Trust Fund monies.[185] Costs to the petroleum industry of a new liability/funding scheme could be significant; costs could, however, also be influenced by programmatic changes in the Superfund system which may be enacted, as discussed below.

Programmatic issues. As the Superfund program has been implemented, criticisms have developed as to the expensiveness of the program and the level of efficiency demonstrated by EPA in its administration of the program. For example, since early in the Superfund program the average cleanup cost per site has tripled, and the Office of Technology Assessment has estimated that 20 to 40 percent of EPA's Superfund expenditures are inefficient.[186] If CERCLA reauthorization were to result in better control of costs and/or increased efficiency of the Superfund program, costs to petroleum companies could be reduced.

NORM. During oil or natural gas production, naturally occurring radioactive material (NORM) sometimes is brought to the surface along with production fluids. NORM can build up as a scale on piping or other equipment, or it can contaminate sludge or produced water. Making existing

requirements more strict or adding additional new requirements could result in more costly compliance measures. EPA is considering regulations (to be proposed as early as December 1993, under authority in the Toxic Substances Control Act) for the management and clean up of NORM at contaminated sites. New federal regulations could involve additional licensing requirements, dose or risk limits, and/or restrictions on further use of contaminated equipment or land. It is also possible that NORM management standards could be mandated through RCRA reauthorization.

3. *Water*

Stormwater Permits. Systems of storm sewers collect and then discharge rainwater and snow run-off, which sometimes carry pollutants. EPA has recently established a regulatory program that requires certain facilities to obtain permits for stormwater discharges. Several aspects of the new program are being finalized. In addition, federal legislation has recently been introduced that would clarify and expand EPA's current program (see separate section).

Although choice is limited in some states, facilities regulated by EPA's current permitting program generally have two compliance options: apply for an individual (site-specific) permit, or apply for a general permit.

NPDES Permits. In November 1990 EPA finalized requirements for NPDES permits (under the Clean Water Act) for certain stormwater discharges.[187] This rule is applicable in states with NPDES program authority. As of September 1992, 39 states and territories had this authority.[188] Under this program, general permits can be obtained only in NPDES states that offer them. Refining and some marketing facilities are subject to these requirements; service stations are exempt. Exploration and production facilities are generally exempt; however, some issues with regard to this exemption are still being resolved.[189]

The costs to the petroleum industry of applying for these permits (which was to have been done by November 1991) were modest. However, if the exemption for exploration and production facilities is eliminated, costs to production facilities to obtain permits may be significant. In addition, as part of its "Phase II" stormwater permitting effort, EPA is considering requiring that service stations obtain permits. Compliance with such a requirement could be costly.

General Permits. EPA issued final rules in September 1992 (for industrial facilities and for construction sites) for general stormwater permits.[190] These rules are effective in states without NPDES permit programs. EPA also is hoping that its general permit program will be a model for states with NPDES permits that have yet to adopt a general permit program. Petroleum refineries and some oil and gas operations are affected.

EPA's general stormwater permit program requires that all affected facilities prepare and implement pollution prevention plans; reporting by certain types of facilities also is required. EPA estimated a range of costs of compliance for individual facilities: initial (first-year) costs of $1,636 to $120,082, and annual costs of $561 to $18,246.[191]

Class V Injection Wells. Under authority in the Safe Drinking Water Act, in order to protect groundwater EPA is planning to propose management standards and permitting and closure requirements for Class V injection wells in the fall of 1993 and finalize these standards in 1994. Class V is a diverse class of injection wells that includes certain septic systems and drainage wells. Thousands of service stations and some marketing terminals are believed to use Class V wells currently, although many wells are being closed as a result of the RCRA toxicity characteristic rule. Exploration and production facilities, petroleum refineries, and petroleum transportation facilities also use Class V wells.

It is possible that new Class V well requirements could be costly to the petroleum industry, due both to the numbers of wells that could be regulated and the costs of compliance at each affected well. For example, on September 11, 1991 EPA and 10 major oil companies entered into agreements under which the companies would close injection wells at 1,800 service stations,[192] under guidelines roughly equivalent to those recently developed by API.[193] At the time, EPA estimated that the 1,800 closures would cost $40 million to $90 million.[194] Thus, assuming that the service stations each have one well, closure costs could average $22,000 to $50,000 per well.

Sediment Analysis and Remediation. Contamination of marine sediments can result from discharges of pollutants into waterways or atmospheric disposition of airborne toxics. While some requirements to analyze sediments and remediate them are in development at EPA, others are being proposed in Congress.

Activity at EPA. Under authority of the Clean Water Act, in 1993 EPA plans to propose a management strategy for sediments and draft aquatic criteria for five organics. The goal of such criteria would be to assess whether aquatic sediments threaten human health or the environment. Remediation requirements may be triggered through RCRA, CERCLA, or other authorities.

Legislative proposals. Since 1990, several Congressional bills have sought to require that EPA consider promulgating sediment quality criteria. One bill recently introduced by Sen. Metzenbaum (D-OH), S. 1183, would give EPA increased authority over sediment management and cleanup in the Great Lakes region.

Sediment remediations could be very costly to perform.

Legislation to Prevent Offshore Leasing. Under authority of the Outer Continental Shelf (OCS) Lands Act and the Submerged Lands Act, the Department of the Interior leases areas to petroleum companies so that they may search for and produce crude oil and natural gas. Several federal bills have recently been proposed to either limit or expand DOI's leasing program. Recent bills that would limit OCS leasing in the interest of protecting the environment include a bill introduced by Rep. Panetta (D-CA) in the 102nd Congress and again early in 1993, H.R. 296, which would allow governors more authority over leases in federal waters off their coastlines. Other examples include bills by Rep. Goss (D-FL) and Sen. Mack (R-FL) (H.R. 583, H.R. 584, and S.290) that would limit oil drilling and leasing off Florida's coast. In contrast, bills by Sen. Johnston (D-LA) and Rep. Fields (R-TX), S. 318 and H.R. 1282, respectively, would encourage OCS leasing.

When a moratorium on leasing is put into effect, companies lose the investment they have made in investigating possible drilling locations and planning to lease particular OCS lands. Petroleum companies also forgo opportunities to produce oil and natural gas.

Clean Water Act Reauthorization Legislation: Wetlands and Effluent Standards for Sectors Other than Refining. Reauthorization of the Clean Water Act is expected to be a focus of the 103rd Congress. A number of issues besides those discussed above (e.g., stormwater, effluent fees) potentially could affect the petroleum industry.

Effluent standards for sectors other than refining. A bill to reauthorize the Clean Water Act proposed in June 1993 by Sens. Baucus (D-Mont.) and Chafee (R-RI), S. 1114, would require more stringent controls on discharges of toxic and other point source pollutants.

Wetlands. Roughly one-third of U.S. oil and gas production comes from wells located in areas that are classified as wetlands. Legislation designed to limit the loss of wetlands could place significant restrictions on oil and gas exploration and development. Alternatively, legislation could force petroleum companies to mitigate effects on wetlands; wetlands mitigation can cost $70 to $230,000 per acre.[195] A

number of bills have been introduced in the 102nd and 103rd Congresses; among them are H.R. 138 (Combest R-TX), H.R. 350 (Edwards D-CA), and H.R. 1330 (Hayes D-Louisiana). The provisions in the Congressional bills vary widely in their potential impacts on the petroleum industry. For example, H.R. 350, which would strengthen existing wetlands protection, offers incentives to keep wetlands in their natural condition and would restrict wetlands mitigation. In contrast, H.R. 1330 would rank wetlands according to their value, allow more extensive development of low-valued wetlands, and compensate some landowners unable to develop more highly-valued wetlands.

4. *Spill Prevention, Response, and Compensation*

Design Standards for Tank Cars. Under the authority of the Hazardous Materials Transportation Uniform Safety Act, DOT is planning to revise specifications for the design of railroad tank cars. In May 1990 DOT issued an advance notice of proposed rulemaking on new specifications for tank car tanks.[196] Pressure from the National Transportation Safety Board may result in design standards for some commodities that are substantially more stringent than is presently the case.

Financial Responsibility Requirements for Offshore Facilities. Under OPA authority, the Minerals Management Service issued an advanced notice of proposed rulemaking in August 1993 for offshore facilities.[197] Financial responsibility requirements would increase from $35 million to $150 million per operator. The requirements could affect not only offshore and coastal oil and gas operations, but inland facilities as well, including pipelines and possibly refineries. Petroleum industry concerns about impacts include the unavailability of insurance and potentially premature abandonment of wells.[198] At the extreme, such effects could limit the availability of crude oil.

Natural Resource Damage Assessments. Federal guidance on assessing natural resource damages can be used by federal or state trustees of public lands in court cases involving spilled oil or hazardous waste contamination. Recovered damage costs are used to restore or acquire damaged resources. Existing guidelines are being revised in ways that could increase costs to petroleum companies.

Guidelines to be Reissued by DOI. In the late 1980s, under authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), DOI promulgated two separate guidances for assessing natural resource damages involving releases of oil or hazardous substances. These regulations included methods for assessing both "use value" losses (losses experienced by those who use affected resources) and "nonuse value" losses (which are experienced by those who do not intend to use the affected resources). For "Type A" cases, in which spills are relatively small, a simplified computer model is used to estimate damages. For "Type B" cases, which are larger and more involved, guidance involves site-specific investigation and assessment. In July 1989 a federal appeals court ruled that these standards undervalued natural resource losses. In response, the Department of Interior proposed revisions to its procedures for assessing damages in "Type B" cases in April 1991.[199] DOI is planning to propose Type A guidance for various types of environments in 1993.[200]

Guidelines to be Issued by NOAA. As directed by the Oil Pollution Act of 1990, the National Oceanic and Atmospheric Administration (NOAA) is developing natural resource damage assessment rules that will replace DOI rules for discharges of oil or hazardous substances into navigable waters.[201] NOAA issued advanced notices of proposed rulemaking in 1990 and 1992, and again in January 1993.[202] NOAA plans to propose a rulemaking later in 1993.[203] As part of this process, NOAA has investigated methods by which nonuse values can be estimated. NOAA established a panel of economists to evaluate the contingent valuation methodology, which assesses nonuse values using surveys. NOAA's panel concluded that, under certain conditions, contingent

valuation could be a valid method for assessing nonuse values.[204]

Assessing the effects of these rules is impossible, as incremental costs partially will be determined by the number and size of accidental releases to the environment. However, several recent developments indicate that cost impacts could be significant for the petroleum industry. First, the pace of natural resource damage claims has accelerated in recent years.[205] Second, stricter standards, such as those for sediment criteria, also could have an impact on the magnitude of assessments in individual cases. Third, settlement amounts can be significant; for example, Shell Oil Co. made payments totaling more than $12 million as a result of an oil spill at one of its refineries in California,[206] and Exxon paid $1 billion to settle suits by the State of Alaska and the federal government as a result of the Valdez spill in 1989.[207] Finally, damage assessment guidelines developed by NOAA as well as DOI may permit the use of the contingent valuation method for assessing nonuse values of natural resources.[208] Nonuse value estimates produced by the contingent valuation methodology can be significant; for example, a recent study for the State of Alaska estimated that the loss of nonuse values associated with the Exxon Valdez oil spill was $2.8 billion.[209]

5. *Multimedia*

Pollution Prevention Directives. Legislation could be passed in the 103rd Congress that would mandate pollution prevention in the form of toxics use reduction (TUR) or required modifications in production processes. Such requirements were proposed in the 102nd Congress. For example, H.R. 2880 would have required extensive toxics use reduction planning and maximum use standards for certain production units. In addition, S. 976, a bill by Sen. Baucus (D-Mont.) to reauthorize RCRA, would have mandated toxics use reduction at facilities that report releases to the TRI.

A bill introduced in June 1993 to reauthorize the Clean Water Act, S. 1114 by Sens. Baucus (D-Mont.) and Chafee (R-RI), would force toxics use reduction: discharges of highly bioaccumulative or toxic pollutants would be phased out over a five-year period, unless safe substitutes are unavailable. In addition the bill would expand EPA authority to consider in-plant process changes when revising industrial effluent guidelines.[210]

Requirements such as toxics use reduction or mandated process changes could be very costly to the petroleum industry.

Pollution Prevention Plan Legislation. Legislation requiring companies to develop pollution prevention plans has been passed in several states. On the federal level, EPA has required that certain companies prepare pollution prevention plans under some of its specific programs (e.g., in conjunction with stormwater permits). In addition, plan requirements have been proposed in Congress as part of CWA and RCRA reauthorizations. For example, S. 1114, (by Sens. Baucus and Chafee), which would reauthorize the Clean Water Act, contains pollution prevention plan mandates. S. 976 (by Sen. Baucus), introduced in the 102nd Congress to reauthorize RCRA, would have required that facilities reporting releases to the TRI must formulate pollution prevention options and goals. Facilities also would have been required to publish summaries of their plans and issue progress reports.

The preparation of pollution prevention plans could be costly to petroleum facilities, as developing plans can involve significant expenditures of time and effort.

EPA Update of Potency Factors for Toxic Pollutants. EPA uses estimated potency factors in conducting risk assessments. Under authority of the Clean Air Act, EPA is reevaluating its potency factors for several chemicals and materials. Several of these (e.g., benzene, gasoline, diesel fuel particulates) are associated with petroleum industry products. Once these potency factors are reassessed, the new values may influence risk assessments conducted under not only the Clean Air Act, but other federal

environmental programs as well (e.g., the Clean Water Act, RCRA); these programs affect all sectors of the petroleum industry. Depending upon how the potency factors are reassessed, federal environmental programs may be made more, or less, stringent.

Reauthorization of the Endangered Species Act. The Endangered Species Act (ESA) is due for reauthorization in the 103rd Congress. The ESA protects plant and animal species, populations, and critical habitats from potential detrimental effects resulting from business activities, including on- and offshore oil and gas production.

Several bills to amend the ESA have been introduced in recent years. Some, which are generally favorable for industry (e.g., H.R. 4058, by Rep. Dannemeyer, R-CA, and H.R. 1490, by Rep. Tauzin, D-La), would encourage (1) more economic analysis before new species are listed as endangered, and/or (2) compensation for implementation actions that cause economic losses. Other bills have sought to make the ESA more stringent. For example, H.R. 2043, by Rep. Studds (D-Mass.), would require federal agencies to protect endangered or threatened species, including species for which listing has been proposed but not finalized. Further, Rep. Studd's bill also seeks to conserve species through the protection of ecosystems. It would also require that federally-approved projects include plans for minimizing or mitigating detrimental impacts.

In a manner similar to more stringent wetlands protection or bans on OCS leasing, a more stringent ESA could curtail exploration and production activity; losses of project investments and production opportunities would result. Unlike bans on OCS leasing, however, it is possible that the ESA could force the closure of petroleum exploration and production operations currently underway, as well as curtailing operations potentially conducted in the future. Although industry activity accompanied by mitigation may be an option, mitigation also can be expensive: it has been estimated that current ESA requirements have increased the cost of dismantling an OCS production platform by about $100,000 to $200,000.[211]

III. The Cost Estimates in Perspective

The above survey indicates that compliance with new and potential federal environmental requirements is expected to require expenditures by the petroleum industry of billions of dollars annually. This section begins by examining the current level of environmental spending by the petroleum industry. A range of likely new and potential expenditures is then estimated, based on the cost estimates for individual requirements discussed above. This estimated range is discussed relative to historic and national expenditure trends. This section ends with a discussion of a number of factors that should be considered when interpreting the results presented.

A. Current Petroleum Industry Environmental Expenditures

Based on API survey data, it has been estimated that the petroleum industry currently spends more than $8 billion per year on activities related to the environment (Table 4). API's survey covers ongoing environmental activities, remediation and spill response, and other activities.

Table 4 also shows that the petroleum industry's spending on environmental activities has grown considerably since the early 1970s. In fact, the industry now spends about the same amount on the environment as it does exploring for oil in the U.S.

B. Aggregated New and Future Annualized Costs

Because of the uncertainty associated with the cost estimates presented above, a simulation technique was used to aggregate new and potential annualized environmental costs to the petroleum industry.[212] More specifically, a Monte Carlo-type process was used to estimate a confidence interval of aggregated costs. Only the annualized estimates listed in Table 1 were used, since the estimates in Table 2 are based on legislation, regulation, or cost estimates that are very uncertain at present.

The point estimates in Table 1 were specified as point estimates in the simulation model. For example, the annualized cost of the stage II controls at service stations regulation shown in Table 1 was modeled as $324 million, with 100 percent probability. When a range of estimates was available, the range was assumed to represent a 95 percent confidence interval based on a normal distribution (e.g., "bell curve"). For example, Table 1 indicates that Phase II RVP reductions will cost between $483 million and $1,669 million annually. For simulation purposes a normal distribution was assumed with a mean of $1,076 million, a probability of 2.5 percent that the true costs of regulation would be less than $483 million, and a probability of 2.5 percent that the true costs would exceed $1,669 million.[213]

Based on the assumed normal distributions, the simulation randomly and independently[214] selected a probable value for each requirement's costs and then summed these numbers. This process was repeated a total of 1,000 times. Figure 1 presents the resulting distribution of the aggregate total cost. This approach effectively says that, over the many environmental requirements, it is very unlikely that the low (or high) cost estimated will occur for every single requirement.

The simulated totals formed a roughly-shaped bell curve. There is a 95 percent probability that the true annualized costs of new and potential environmental requirements to the petroleum industry will be between $17,273 million and $24,691 million, if the ranges of costs presented in Table 1 are accurate.

C. Historical and Nationwide Contexts

Two methods of assessing the reasonableness of the aggregate environmental cost estimates are to examine them in a historical context (relative to petroleum industry expenditures in the past) and in relation to U.S. expenditures on environmental controls. Data exist with which to make tentative

Table 4.

Spending by the U.S. Petroleum Industry on Exploration for Oil and on Environmental Activities, During Various Years

Petroleum Industry Activity	Expenditures (Billions of 1991 Dollars) 1973	1981	1990
U.S. Exploration for Oil	14.2	45.0	7.6
Environmental Activities	3.7	8.4	8.1

Note: (1) Expenditure estimates are converted to 1991 dollars using the GNP deflator values in Appendix B. (2) Estimates of environmental expenditures for 1973 and 1981 were extrapolated to 100 percent of refining capacity based on estimated shares of refining capacity reflected in survey responses. The share for 1973 is somewhat unclear.

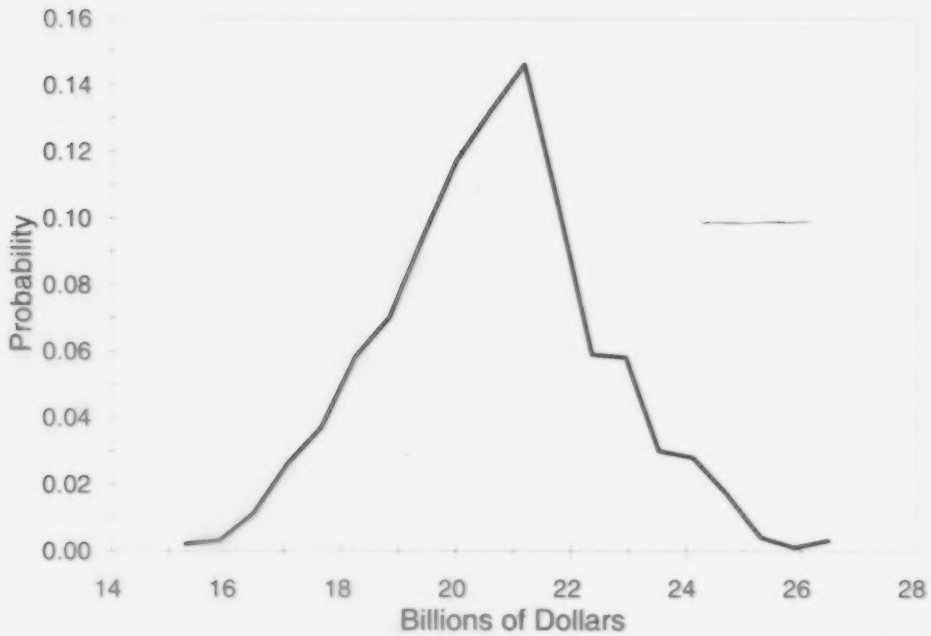
Sources: U.S. Exploration Expenditures: API, *Basic Petroleum Data Book*, vol. XIII no. 2, May 1993, Sec. V, Tables 9 and 9a.

Environmental Expenditures, 1973 and 1981: API, "Environmental Expenditures of the United States Petroleum Industry: 1972-1981," Publication No. 4351, [1981], pp. 2 and 5.

Environmental Expenditures, 1990: API, "Petroleum Industry Environmental Performance 1992," [1992], pp. 34-40.

Figure 1.

Likely Values of Total Annualized Costs of New and Potential Environmental Requirements to the Petroleum Industry, Estimated by Simulation



Source: Simulation based on annualized cost estimates in Table 1.

comparisons: EPA recently has published a report examining historical and projected environmental expenditures, and API in the past has conducted surveys of petroleum industry expenditures on pollution controls.

Figure 2 presents estimates of petroleum industry environmental expenditures (in 1991 dollars), by medium, for 1972 to 1984, 1990 and 1991, and the year 2000. These estimates are based on API surveys[215] and the estimates made in this paper. As illustrated, adding the new aggregate environmental costs to current spending of more than $8 billion per year amounts to total environmental costs of $26 billion to $33 billion per year for the year 2000.

Figure 2 would seem to indicate that the cost projections for the year 2000 are very high by historical standards. However, when compared to past and projected national expenditures for pollution control (estimated by EPA), the petroleum cost estimates may not seem very high. Figure 3 indicates that in the mid-1970s and in 1980 the petroleum industry's share of expenditures approached the low share now estimated for the year 2000 -- 13.5 percent.

The validity of the comparisons made in Figure 3 may be questioned on the grounds that the petroleum industry and national expenditure estimates for the 1970s and 1980s were derived from different sets of data collected under different circumstances and perhaps using different assumptions. Appendix C compares the data used by EPA with API's survey data and concludes that although the API estimates of petroleum industry expenditures are generally somewhat higher than those used by EPA, the EPA and API estimates of environmental expenditures are roughly comparable.

It is worth noting, however, that EPA's study, which was completed in 1990, does not include national cost estimates for some of the environmental requirements for the petroleum industry examined in this paper. For instance, EPA's study does not include cost estimates associated with the Oil Pollution Act of 1990.[216] If EPA's national cost projections underestimate potential national costs, then the shares attributable to the petroleum industry presented in Figure 3 may be overestimates.

D. General Considerations Regarding Estimated New and Future Costs

A number of factors should be considered with regard to the results presented above.

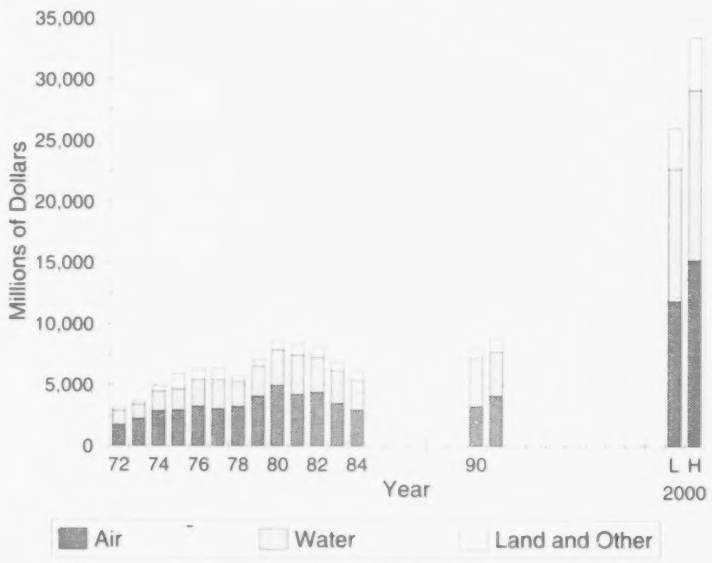
First, the validity of this simulated range of total annualized new and potential costs rests not only on the validity of individual cost estimates but also on the degrees to which future costs are left out or double-counted. For example, requirements for which no cost estimates are presently available are not included, so the total range may underestimate likely costs. In addition, although this paper does not cover new and future requirements emerging exclusively at the state level, state requirements are developing rapidly and can be very costly to affected petroleum operations. On the other hand, despite efforts to avoid double counting, some of the requirements for which costs presented in Table 1 may overlap, and thus there could be some double counting of some future expenditures, leading to an overstatement of costs.

Second, the accuracy of individual cost estimates, and their comparability, depend in part upon the extent to which consistent methodologies were used in preparing the estimates. Given that methodologies differ in some cases (e.g., with regard to discount rate), care is advised in comparing individual cost estimates with others and in comparing the costs aggregated here with national totals.

Third, it would be useful to estimate the timing of initial and on-going expenditures to comply with environmental requirements. This type of analysis could, for example, correct the year 2000 estimates for any expenditures that may peak in the 1990s and then diminish. Such an analysis, however, would require careful estimations of expected capital expenditures

Figure 2.

Estimates of Environmental Expenditures Made by the Petroleum Industry, by Medium, for Various Years



Note: (1) Estimates are in 1991 dollars. (2) Estimates are not available for years 1985-1989 and 1992-1999. (3) Estimates for 1972 to 1984 were extrapolated to 100 percent of refining capacity based on estimated shares of refining capacity reflected in survey responses. This share for 1972 and 1973 is somewhat unclear. (4) Estimates for 2000 based on 1991 estimate and simulation results described in this paper. Distribution by medium was based on percentage shares of simulated mean of total costs.

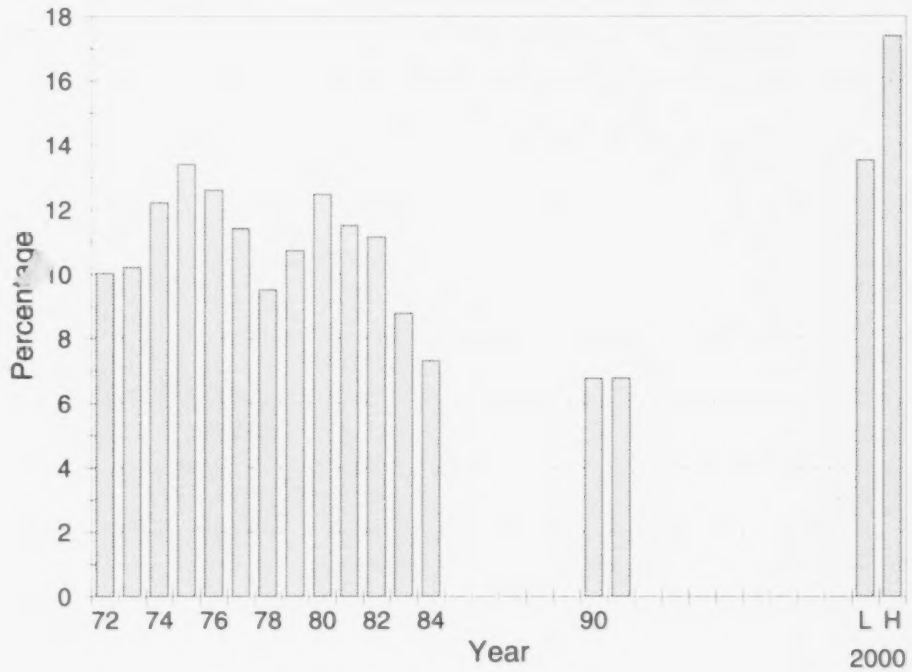
Sources: 1972 to 1984 estimates: API, "Environmental Expenditures of the United States Petroleum Industry: 1972-1981," Publication No. 4351, [1981], pp. 2 and 5; API, "Environmental Expenditures of the United States Petroleum Industry: 1975-1984," Publication No. 4404, [1985], pp. 2 and 6.

1990 and 1991 estimates: API, "Petroleum Industry Environmental Performance 1992," [1992], pp. 34-40; and API, "Environmental Expenditures of the U.S. Petroleum Industry: 1991," May 1993 draft report, forthcoming.

Of GNP Deflator: EPA, *Environmental Investments: The Cost Of A Clean Environment*, Report to Congress, (Washington, DC: November 1990), p. 1-14, and "National Income and Product Accounts Tables," *Survey of Current Business*, 72 no. 7, July 1992, Table 7.3 (See Appendix B).

Figure 3.

Estimates of Environmental Expenditures Made by the Petroleum Industry as a Share of Nationwide Environmental Expenditures, for Various Year



Note: Estimates are not available for years 1985-1989 and 1992-1999.
U.S. total expenditures adjusted to 1991 dollars using a GNP deflator.

Sources: For petroleum industry expenditures: Estimates presented in Figure 2 above.

For U.S. total environmental expenditures: EPA, *Environmental Investments: The Cost Of A Clean Environment*, Report to Congress, November 1990, Tables 8-17 and 8-17A and p. 1-14.

Of GNP deflator: EPA, *Environmental Investments: The Cost Of A Clean Environment*, Report to Congress, November 1990, p. 1-14, and "National Income and Product Accounts Tables," *Survey of Current Business*, 72 no. 7, July 1992, Table 7.3 (See Appendix B).

and capital lifetimes that are beyond the scope of this paper.

Fourth, it would be useful to be able to assess the general validity of expenditure estimates made for environmental requirements.[217] For example, such analyses can overstate costs because unrealistic scenarios are assumed. Having such perspective would help evaluate not only the petroleum industry expenditures, but EPA's general findings also.

Fifth, the extent to which true expenditures will approximate those estimated here partially depends upon the extent to which the petroleum industry is able to find ways of reducing pollution abatement costs. During its history, the petroleum industry has adopted many innovative means of improving its management of potentially harmful substances.[218] New pollution abatement technologies or process changes could make the levels of environmental protection sought by the new requirements achievable at a cost less than estimated at present, given current technologies.

Sixth, API recently has renewed its survey of annual expenditures on environmental protection made by petroleum companies. Results for 1990 and 1991 are used in the present study. The results of surveys conducted in the future may yield additional perspective on the costs and trends noted here.

Finally, assessing the full impacts of new environmental requirements entails more than an examination of potential expenditures. As the petroleum industry adjusts to new requirements over the long term, the economic behavior of many sectors of the U.S. economy may be affected. For example, it has recently been estimated that the Clean Air Act Amendments of 1990 will cause a 2 percent increase in petroleum refinery product prices in the year 2005, while output quantities will fall by more than 2 percent;[219] this estimate, however, may be low, as it apparently does not consider the costs of the clean fuels program.[220] The total new compliance costs of $17 billion to $25 billion per year estimated in this paper could be large enough to significantly affect petroleum product prices, quantities produced, and demand for imports. A comprehensive analysis of impacts would trace the effects of new environmental expenditures on the U.S. economy and assess the resulting costs in relation to the benefits brought about by the requirements.[221]

IV. Conclusions

New and potential federal environmental requirements could affect all sectors of the U.S. petroleum industry in this decade. Requirements differ greatly with respect to the degree to which their cost impacts can be estimated at present: some requirements are well specified and cost data are available, while other potential requirements are vague and have less predictable effects. Even where cost estimates exist, significant uncertainty is apparent.

Based on the available cost estimates, this paper estimates that annualized new and potential environmental costs to the petroleum industry will likely range between $17 billion and $25 billion by the end of the 1990s. The petroleum industry may incur about 14 to 17 percent of national environmental expenditures in the year 2000. This would be a larger share than the industry incurred in the mid-1980s, but the lower end of this range approximates the industry's share in the mid-1970s and in 1980.

This paper finds aggregate new and potential compliance costs that are similar in magnitude to estimates made in a similar, previous study.[222] While several individual cost estimates from the previous study do not explicitly appear in the current one (because significant expenditures were likely to have been incurred in 1991), some cost estimates were modified based on new information, and several new cost estimates were added. In some cases additions were due to a new regulatory development (e.g., EPA's proposed rule on Great Lakes Water Quality). In other cases, cost estimates only have recently become available for legislated requirements or sets of requirements. Several provisions in the Clean Air Act Amendments of 1990 fit into this category (e.g., nonattainment, permitting, emission standards for OCS exploration and production facilities). So too do the OPA oil spill response plan requirements for vessels, onshore oil pipelines, and other facilities.

In considering the cost estimates presented in this paper, two factors should be noted. First, given the quality of the data available and the uncertainties associated with them, aggregate estimates should be treated as approximations. Second, an assessment of the full impacts of new environmental requirements would entail more than an examination of potential expenditures. As the petroleum industry adjusts to new requirements over the long term, the economic behavior of many sectors of the U.S. economy may be affected. A comprehensive analysis of impacts would trace the effects of new requirements on the U.S. economy and assess the resulting costs in relation to the benefits brought about by the requirements.

Appendix A

Estimation of Clean Gasoline Costs

As discussed above, EPA has issued various proposed and final rules to implement the clean gasoline program outlined in Title II of the Clean Air Act Amendments of 1990. This appendix estimates total costs based on potential clean gasoline market sizes and estimated costs per gallon of fuel. The assumptions used are summarized in Table A-1.

Sizes of Potential Markets

Using gasoline sales data for 1989, API estimated the sizes of various markets for clean gasolines. Table A-2 shows sizes (in millions of gallons per year) of various markets or potential markets for clean gasolines. For markets that could opt-in to the reformulated gasoline (RFG) program, Table A-2 also presents total gasoline sales for the relevant cities in states that have already committed to opt-in.

Table A-3 shows how these markets are categorized for the purpose of estimating total oxygenated gasoline and RFG Phase I costs. Classification as oxygenated gasoline or RFG dictates the seasonal adjustment factor(s) (discussed below) and cost per gallon estimate(s) applied later in the analysis. As Table A-3 shows, for the lower total cost estimate, uncommitted RFG opt-in markets are excluded. This yields a total of 51.8 billion gallons/year: 13.8 billion gallons/year of oxygenated gasoline and 37.9 billion gallons/year of RFG. For the higher cost estimate, all areas that may opt-in to the RFG program are assumed to do so. This yields a total of 69.1 billion gallons/year: 7.1 billion gallons/year of oxygenated gasoline and 62.0 billion gallons/year of RFG.

Table A-4 shows market sizes for RFG Phase II. For the lower cost estimate, a market size of 25.4 billion gallons/year is assumed (based on mandatory market sizes). The higher cost estimate assumes full RFG opt-in; this amounts to 36.6 billion gallons/year.

Seasonal Adjustment Factors

Adjustment factors were used to reflect the seasonal nature of clean gasoline requirements. Multiplying a given fuel's annual market size by its adjustment factor yields a more accurate estimate of expected yearly sales.

Oxygenated Gasoline. Oxygen requirements are effective for 4 to 12 months per year, depending on the individual area's pattern of exceeding carbon monoxide standards. The effective oxygenate requirement is roughly equal to a 5 month requirement for all carbon monoxide nonattainment areas (after allowing for delivery times, the relative sizes of different nonattainment areas, and their different control periods).[223] Thus, for oxygenated gasoline, the seasonal reduction factor is 0.42 (= 5 months/12 months).

Reformulated Gasoline. Many RFG requirements are year-round (i.e., minimum or maximum contents of oxygen, benzene, heavy metals; NOx and TAPs emission standards). Requirements for VOC reduction, however, are effective only during the summer high ozone season, which EPA has defined as June 1st through September 15th.[224] Since refining RFG for sale during the summer will be more expensive than refining RFG for sale during the rest of the year, seasonal "summer" and "winter" adjustment factors are necessary. The effective summer RFG availability requirement will be roughly equal to 4.5 months -- EPA's 3.5 month period plus a compliance margin of 1 month. Thus, a summer adjustment factor of 0.37 (= 4.5 months/12 months) is assumed. Since the winter adjustment factor covers the rest of the year, its value is 0.63 (= 1.00 - 0.37).

Table A-1
Major Assumptions for Estimating Clean Gasoline Costs

Item	Value	Table or Text Reference
Seasonal Adjustment Factors		
Oxygenated Gasoline	0.42	Text
RFG (Phases I and II, Summer)	0.37	Text
RFG (Phases I and II, Winter)	0.63	Text
Oxygenated Gasoline and Reformulated Gasoline Phase I		
Lower Cost Estimate:		
Oxygenated Gasoline Mrkt Size (mil gals/yr)	13,843*	Table A-3
Oxygenated Gasoline Cost (¢/gal)	3	Table A-5
RFG Phase I Market Size (mil gals/yr)	37,932*	Table A-3
RFG Phase I Summer Cost (¢/gal)	4	Table A-5
RFG Phase I Winter Cost (¢/gal)	3.5	Table A-5
Upper Cost Estimate:		
Oxygenated Gasoline Mrkt Size (mill gals/yr)	7,133*	Table A-3
Oxygenated Gasoline Cost (¢/gal)	5	Table A-5
RFG Phase I Market Size (mill gals/yr)	61,965*	Table A-3
RFG Phase I Summer Cost (¢/gal)	7	Table A-5
RFG Phase I Winter Cost (¢/gal)	3.5	Table A-5
Reformulated Gasoline Phase II (Incremental Costs over Phase I)		
Lower Cost Estimate:		
RFG Phase II Market Size (mill gals/yr)	25,358	Table A-4
RFG Phase II Summer Cost (¢/gal)	3	Table A-5
RFG Phase II Winter Cost (¢/gal)	2	Table A-5
Upper Cost Estimate:		
RFG Phase II Market Size (mill gals/yr)	61,965	Table A-4
RFG Phase II Summer Cost (¢/gal)	20	Table A-5
RFG Phase II Winter Cost (¢/gal)	2	Table A-5

* Note: For individual markets that must sell both oxygenated gasoline and RFG Phase I, the market size is counted as RFG Phase I.

Table A-2

Clean Gasoline Market Sizes (Annual Basis) and RFG Committed Opt-In

Reason for Market	Market Size (million gals/yr)	Committed RFG Phase I Opt-In (million gals/yr)[a]
CO Only Nonattainment	7,133	NA
CO Nonattainment and RFG Opt-In	10,750	4,040
CO Nonattainment and RFG Mandatory	19,099	NA
RFG Mandatory only	6,259	NA
RFG Opt-In Only	25,857	8,534
Total	69,098	12,574

Note: These estimates are based on 1989 gasoline sales data. Source: Russell O. Jones and Thomas J. Lareau, "Meeting The Oxygenate Requirements Of The 1990 Clean Air Act Amendments," API Research Study #058, June 1991, pp. 34-37.

[a] These amounts are sold in qualifying cities in states that have opted-in to the RFG Phase I program: Maine, New Hampshire, Rhode Island, Pennsylvania, Maryland, Delaware, Virginia, Texas, Connecticut, Massachusetts, New Jersey, New York, and District of Columbia.

Table A-3

Market Classifications and Sizes (Annual Basis) for Purposes of Estimating Oxygenated Gasoline and RFG Phase I Costs

End of Cost Range/ Reason for Market	Classification	Market Size (million gals/yr)
Lower Cost Estimate:		
CO Only Nonattainment	Oxy	7,133
CO Nonattainment	Oxy	6,710
and RFG Opt-In	RFG	4,040
CO Nonattainment and RFG Mandatory	RFG[a]	19,099
RFG Mandatory	RFG	6,259
RFG Opt-In only	RFG	8,534
Total		51,775[b]
Upper Cost Estimate:		
CO Only Nonattainment	Oxy	7,133
CO Nonattainment and RFG Opt-In	RFG	10,750
CO Nonattainment and RFG Mandatory	RFG[a]	19,099
RFG Mandatory	RFG	6,259
RFG Opt-In only	RFG	25,857
Total		69,098[c]

Note: "Oxy" refers to oxygenated gasoline.
"RFG" refers to reformulated gasoline.

[a] This classification yields expected costs, based on the most costly mandatory requirements.

[b] Totals by fuel type: Oxygenated Gasoline: 13,843 (million gals/yr)
RFG Phase I: 37,932 (million gals/yr)

[c] Totals by fuel type: Oxygenated Gasoline: 7,133 (million gals/yr)
RFG Phase I: 61,965 (million gals/yr)

Table A-4

RFG Phase II: Range of Market Sizes (Annual Basis)

Reason for Market	RFG Mandatory (million gals/yr)	RFG Opt-In (million gals/yr)
CO Only Nonattainment	0	0
CO Nonattainment and RFG Opt-In	0	10,750
CO Nonattainment and RFG Mandatory	19,099	0
RFG Mandatory	6,259	0
RFG Opt-In	0	25,857
Totals	25,358	36,607

Note: For the lower cost estimate, the market is assumed to consist of mandatory fuel sales only (25,358 million gals/yr). For the upper cost estimate, the market is assumed to consist of both mandatory and opt-in fuel sales (61,965 million gals/yr).

Estimated Costs Per Gallon

Various estimates have been made as to the added costs of refining oxygenated gasoline and RFG Phase I and II over the cost of refining conventional gasoline. Table A-5 summarizes these cost per gallon estimates. For this analysis, the low and high estimates for each gasoline type presented define an estimated cost range.

Oxygenated Gasoline Costs. The range of costs is about 3¢/gallon to 5¢/gallon, based on preliminary Department of Energy data for oxygenated gasoline sold early in 1993.

Reformulated Gasoline Costs. Production cost estimates are presented for both winter and summer. Since total RFG Phase II costs are later calculated as costs over and above RFG Phase I costs, cost per gallon estimates for Phase II are presented twice: once on an incremental basis over conventional gasoline costs, and once as incremental over RFG Phase I costs. (The consumer faces an effective cost for reformulated gasoline that is higher than the refining cost, because reformulated gasoline has a lower energy content than conventional gasoline.)

For RFG Phase I: Summer cost estimates vary between 4¢/gallon and 7¢/gallon. Winter costs are estimated at 3.5¢/gallon.

For RFG Phase II, Winter: Refining costs are estimated at 5.5¢/gallon; this is 2¢/gallon more than the winter RFG Phase I cost estimate.

For RFG Phase II, Summer: As reflected in Table A-5, cost estimates have varied widely, in part because final requirements have not yet been outlined by EPA. Using several sources, Table A-5 presents a range of cost estimates, from 7¢/gallon to 24¢/gallon. The range of RFG Phase II estimates for incremental costs over RFG Phase I is 3¢/gallon to 20¢/gallon; the calculations used for individual estimates are presented in Table A-5.

Total Estimated Costs

Using the estimated values summarized in Table A-1, high and low total annual costs were estimated for each gasoline type by first multiplying market sizes by seasonal adjustment factors, then multiplying the results by the estimated costs per gallon. Table A-6 shows the results of these calculations.

For oxygenated gasoline and Phase I RFG together, total annual costs are estimated to be $1.571 billion to $3.121 billion. For RFG Phase II, total costs (over and above RFG Phase I costs) are estimated at $601 million to $5.366 billion per year.

Table A-5

Refinery Cost Per Gallon Estimates for Oxygenated Gasoline, RFG Phase I, and RFG Phase II

Gasoline	End of Cost Range	Cost Estimate (cents/gallon)[a]	Source of Estimate	Comments on Estimate[b]
Oxygenated Gasoline	Low	3	EIA[c]	Based on actual prices in 1993
	High	5	EIA[c]	Based on actual prices in 1993
RFG Phase I (Summer)	Low	4	DRI	For PADD I: 3.6¢/gal.
		5.5	NPC	Estimated explicitly for summer
	High	7	DRI	For PADD I: 6.7¢/gal.
RFG Phase I (Winter)		3.5	NPC	= Summer est. - 2¢/gal.[d]
RFG Phase II (Winter)		5.5	NPC	= Summer low est. of 7.5¢/gal. - 2¢/gal.[d]
RFG Phase II (Winter), Incremental Over Phase I		2	NPC	= 5.5 ¢/gal. - 3.5 ¢/gal.

Table A-5 (Continued)

Refinery Cost Per Gallon Estimates for Oxygenated Gasoline, RFG Phase I, and RFG Phase II

Gasoline	End of Cost Range	Cost Estimate (cents/gallon)[a]	Source of Estimate	Comments on Estimate[b]
RFG Phase II (Summer)	Low	7	Auto/Oil	For PADD III, IRR 9%[c]
		7.6 - 9.6	NPC	Cost will depend on final RFG requirements
		12	NPC	Based on EPA's 2/93 proposed rule
		16.8	DRI	Low est. for CA RFG Phase II
		17	NPC	For CA RFG Phase II
		20.5	Auto/Oil	For PADD I, IRR 13%, plus sulfur control[e,f]
	High	23.8	DRI	High est. for CA RFG Phase II
RFG Phase II (Summer), Incremental Over Phase I	Low	3	NPC	= Avg. of (7.6¢/gal. - 5.5¢/gal.) and (9.6¢/gal. - 5.5¢/gal.)
		3	Auto/Oil	= 7¢/gal. (Auto/Oil) - 4¢/gal. (Low RFG Ph. I est.)
		6.5	NPC	= 12¢/gal. est. - 5.5¢/gal.
		8.8 - 12.8	DRI	= 16.8¢/gal. (DRI) - 4 to 7¢/gal. (Range for RFG Ph. I)
		11.5	NPC	= 17¢/gal. est. - 5.5 ¢/gal.
		12.5 - 16.5	Auto/Oil	= 20.5¢/gal. (Auto/Oil) - 4 to 7¢/gal. (Range for RFG Ph. I)
	High	15.8 - 19.8	DRI	= 23.8¢/gal. (DRI) - 4 to 7¢/gal. (Range for RFG Ph. I)

[a] Unless otherwise noted, cost estimated is an increase over the production cost of conventional gasoline. (Because the energy content of RFG is less than the energy content of conventional gasoline, consumers in effect pay about 2 to 3 cents per gallon more than the higher production cost for RFG.)

Table A-5 (Continued)

Refinery Cost Per Gallon Estimates for Oxygenated Gasoline, RFG Phase I, and RFG Phase II

[b] Some calculations reproduce those given or implied by an original source, while other calculations are partly original. For example, NPC's winter RFG Phase I cost was calculated by subtracting (as NPC does) 2¢/gal. from NPC's summer cost estimate of 5.5¢/gal. The estimated Auto/Oil incremental cost of summer Phase II RFG of 3¢/gal., however, is calculated by subtracting the low cost estimate for summer RFG Phase I (4¢/gal.) from Auto/Oil's summer Phase II cost estimate of 7¢/gal.

[c] EIA is the Energy Information Administration, a division of the Department of Energy.

[d] The estimate of 2¢/gal. is derived from NPC's annual and summertime cost estimates.

[e] "IRR" refers to the "internal rate of return" assumed. Phase II RFG corresponds roughly to Auto/Oil's "Fuel aMot."

[f] Sulfur control costs are estimated at 4.6¢/gal.; this is Auto/Oil's high estimate for PADD I using an IRR of 13%.

Sources:

EIA: "EIA Report Says Oxygenate Demand is Less than Expected, Supplies are Sufficient," *New Fuels Report*, March 1, 1993, pp. 15-16.

DRI: DRI/McGraw Hill, "Assessing the Economic Effects of Northeastern States Adoption: California's Low Emission Vehicle Program -- Volume II - Appendices," for API, November 1991, Appendix B.

Auto/Oil: Auto/Oil Air Quality Improvement Research Program, "Estimated Costs of Modifying Gasoline Properties," Economics Bulletin No. 2, January 1992, pp. 16 and 19.

NPC: National Petroleum Council, *U.S. Petroleum Refining*, forthcoming, Chapter 4.

Table A-6

Total Estimated Cost Ranges for Oxygenated Gasoline and RFG Phase I and for RFG Phase II (Annual Basis)

Fuel and End of Cost Range	Total Annual Refining Cost ($ million)
Oxygenated Gasoline and Reformulated Gasoline Phase I	
Lower Cost Estimate:	
Oxygenated Gasoline	174
RFG Phase I, Summer	561
RFG Phase I, Winter	836
Total	1,571
Upper Cost Estimate:	
Oxygenated Gasoline	150
RFG Phase I, Summer	1,605
RFG Phase I, Winter	1,366
Total	3,121
Reformulated Gasoline Phase II (Incremental Costs over Phase I)	
Lower Cost Estimate	
RFG Phase II, Summer	188
RFG Phase II, Winter	319
Total	507
Upper Cost Estimate:	
RFG Phase II, Summer	4,585
RFG Phase II, Winter	781
Total	5,366

Appendix B

Gross National Product Deflator, 1972 - 1991

A Gross National Product (GNP) deflator was used to convert some individual environmental requirement cost estimates to $1991. The same index was used to convert petroleum industry and U.S. aggregate environmental cost estimates to $1991. The GNP deflator values used are presented in Table B-1.

GNP deflator values for 1972 to 1990 were those used by EPA in calculating U.S. aggregate environmental cost estimates. EPA's values are based on fixed-weighted indexes.[225]

A GNP deflator value for 1991 was derived by multiplying EPA's 1990 value (1.153) by the ratio of values for 1991 and 1990 of a fixed-weighted (1987) GNP price index. U.S. government values for 1991 and 1992 are 118.1 and 113.5, respectively.[226] The 1991/1990 ratio is 1.04053. Thus, the value for 1991 is calculated to be 1.2 (= 1.153 x 1.04053).

Table B-1

Values of Gross National Product (GNP) Deflator, 1972-1991

Year	Value	Year	Value
1972	0.437	1982	0.869
1973	0.461	1983	0.904
1974	0.497	1984	0.941
1975	0.537	1985	0.974
1976	0.566	1986	1.000
1977	0.594	1987	1.035
1978	0.632	1988	1.071
1979	0.685	1989	1.113
1980	0.748	1990	1.153
1981	0.818	1991	1.200

Sources: Values for Years 1972-90: EPA, *Environmental Investments: The Cost Of A Clean Environment*, Report to Congress, (Washington, DC: November 1990), p. 1-14. Values are based on fixed-weighted indexes.

Value for 1991: Calculated by multiplying EPA's 1990 value (1.153) by the ratio of 1991 to 1990 values of a fixed-weighted (1987) GNP price index. Source of 1991 and 1990 fixed-weighted (1987) GNP price index values (118.1 and 113.5, respectively): "National Income and Product Accounts Tables," *Survey of Current Business*, 72 no. 7, July 1992, Table 7.3.

Appendix C

Comparison of API and DOC Estimates of Petroleum Industry Environmental Expenditures

This appendix assesses the consistency between the petroleum environmental expenditure estimates made by API and the data used by EPA in estimating nationwide environmental expenditures made during the 1970s and 1980s.

EPA's estimates are based on survey data collected by the Department of Commerce (DOC).[227] Figure C-1 compares API and DOC estimates of petroleum industry capital expenditures made for environmental quality and protection during the 1970s and 1980s. Although the API estimates generally are higher, in some years the two estimates are close, and DOC's estimate for 1978 exceeded API's.

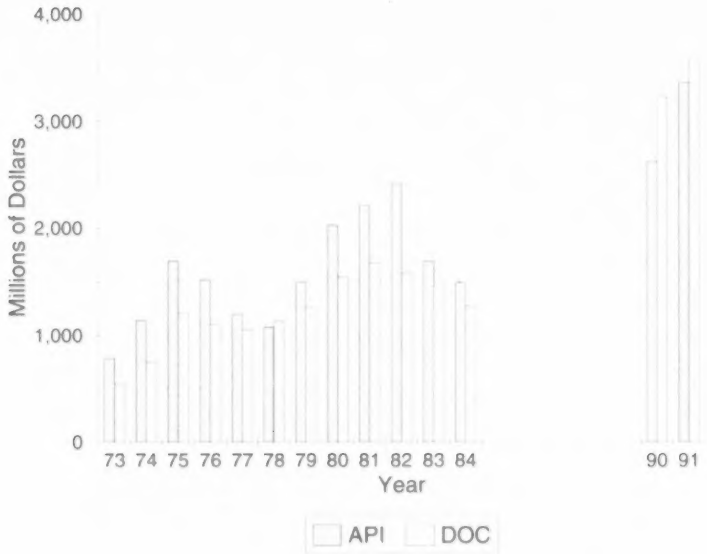
Figure C-2 compares API and DOC capital plus operating expenditures made by petroleum refineries in various years. API's estimates are consistently higher than DOC's, but not by a wide margin in many years.

Given the results of the comparisons presented in Figures C-1 and C-2, it is concluded that although the API estimates of petroleum industry expenditures are generally somewhat higher than those used by EPA, the EPA and API estimates of environmental expenditures are roughly comparable.

For comparison, API and DOC estimates of 1990 and 1991 expenditures are also presented in Figures C-1 and C-2. Although environmental spending levels are higher than expenditures in the 1970s and 1980s, the relationship between API and DOC estimates is roughly consistent with trends for earlier years. The API and DOC estimates for 1990 and 1991 are roughly comparable. Figure C-1 indicates, however, that DOC's petroleum capital expenditure estimates were slightly higher than API's, while refinery expenditure estimates (Figure C-2) made by API were higher than those made by DOC.

Figure C-1.

Estimates of Capital Expenditures by the Petroleum Industry Made for Environmental Protection, for Various Years



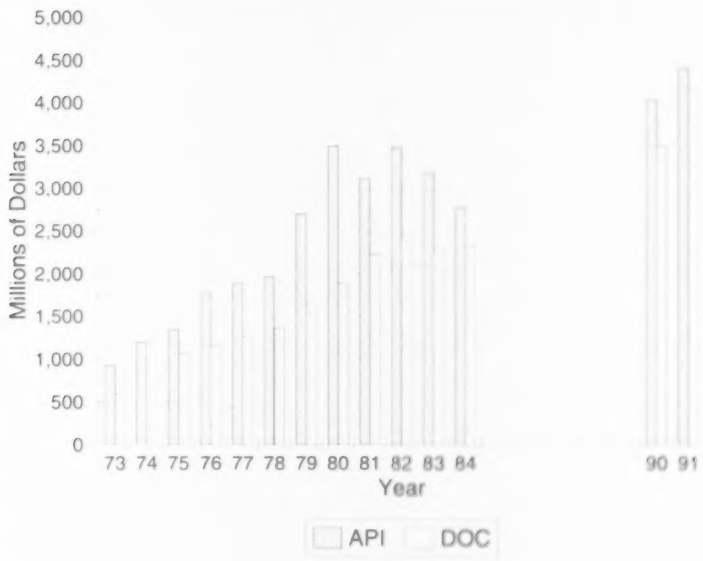
Note: (1) Estimates are in current dollars. (2) DOC estimate for 1984 was preliminary. (3) API estimates for 1973 through 1984 were extrapolated to 100 percent of refining capacity based on estimated shares of refining capacity reflected in survey responses. This share for 1973 is somewhat unclear. (4) Some API capital expenditure estimates for 1991 were estimated based on data for 1990.

Sources: Of API estimates: API, "Environmental Expenditures of the United States Petroleum Industry: 1972-1981," Publication No. 4351, [1981], pp. 2 and 5; API, "Environmental Expenditures of the United States Petroleum Industry: 1975-1984," Publication No. 4404, [1985], pp. 2 and 6; API, "Petroleum Industry Environmental Performance 1992," [1992], pp. 34-40; and API, "Environmental Expenditures of the U.S. Petroleum Industry: 1991," May 1993 draft report, forthcoming.

Of DOC estimates: DOC, Environmental Economics Division, "Plant and Equipment Expenditures by Business for Pollution Abatement: Revised Estimates for 1973-83, Estimates for 1984," *Survey of Current Business*, 66 no. 2, February 1986, pp. 40-41; and DOC, "Current Industrial Reports: Pollution Abatement Costs and Expenditures, 1991," January 1993, Table A.

Figure C-2.

Estimates of Capital Plus Operating Expenditures by Petroleum Refiners Made for Environmental Protection, for Various Years



Note: (1) Estimates are in current dollars. (2) Estimates are not available for 1974. (3) API estimates for 1973 through 1984 were extrapolated to 100 percent of refining capacity based on estimated shares of refining capacity reflected in survey responses. This share for 1973 is somewhat unclear. (4) Some API capital expenditure estimates for 1991 were estimated based on data for 1990.

Sources: Of API estimates: API, "Environmental Expenditures of the United States Petroleum Industry: 1972-1981," Publication No. 4351, [1981], pp. 2, 7, and 8; API, "Environmental Expenditures of the United States Petroleum Industry: 1975-1984," Publication No. 4404, [1985], pp. 2, 7, and 8; API, "Petroleum Industry Environmental Performance 1992," [1992], pp. 34-40; and API, "Environmental Expenditures of the U.S. Petroleum Industry: 1991," May 1993 draft report, forthcoming.

Of DOC estimates: DOC, Bureau of the Census, "Pollution Abatement Costs and Expenditures Survey," results for 1973 through 1984; DOC, "Current Industrial Reports: Pollution Abatement Costs and Expenditures, 1990," April 1992, Tables 3a and 4a; and DOC, "Current Industrial Reports: Pollution Abatement Costs and Expenditures, 1991," January 1993, Tables 3a and 4a.

Notes

1. Jody Perkins, "Costs to the Petroleum Industry of Major New and Future Federal Government Environmental Requirements," API Discussion Paper #070, October 1991.

2. EPA, "Semiannual Regulatory Agenda," *Federal Register*, 58 no. 78, April 26, 1993, pp. 24996-25090.

3. EPA, "National Emission Standards for Hazardous Air Pollutants; Benzene Emissions from Chemical Manufacturing Process Vents, Industrial Solvent Use, Benzene Waste Operations, Benzene Transfer Operations, and Gasoline Marketing System," Final Rule, *Federal Register*, 55 no. 45, March 7, 1990, p. 8292.

4. EPA, "National Emission Standards for Hazardous Air Pollutants; Benzene Waste Operations," Final Rule, *Federal Register*, 57 no. 44, March 5, 1992, p. 8012.

5. EPA, "National Emission Standards for Hazardous Air Pollutants; Benzene Waste Operations," Final Rule, *Federal Register*, 58 no. 4, January 7, 1993, p. 3072.

6. EPA, "National Emission Standards for Hazardous Air Pollutants, Benzene Waste Operations," Advance Notice of Proposed Rulemaking, *Federal Register*, 58 no. 54, March 23, 1993, p. 15457.

7. See API, "Supplement to the American Petroleum Institute's Petition for Reconsideration of the National Emission Standards for Hazardous Air Pollutants for Benzene Waste Operations," May 30, 1991, pp. 4 and 5 and Appendix B.

8. Aggregate of survey responses to the March 1991 survey.

9. API submitted blinded survey responses to EPA in September 1991.

10. Letters from C.J. Krambuhl (API) to members of API's General Committee on Refining, June 22, 1993 and July 7, 1993, and attachments.

11. EPA, "Volatility Regulations for Gasoline and Alcohol Blends Sold in Calendar Years 1992 and Beyond," Final Rule, *Federal Register*, 55 no. 112, June 11, 1990, p. 23658.

12. API, "API Comments on EPA's Draft Regulatory Impact Analysis on the Control of Gasoline Volatility and Evaporative Hydrocarbon Emissions: Attachment 2, Costs of RVP Reductions," February 5, 1988, p. A-2.

13. EPA, "Volatility Regulations for Gasoline and Alcohol Blends Sold in Calendar Years 1992 and Beyond," Final Rule, p. 23663. API's comments imply that EPA's estimates include amortized capital costs; see, e.g., p. A-3.

14. EPA, "Regulation of Fuels and Fuel Additives: Fuel Quality Regulations for Highway Diesel Fuel Sold in 1993 and Later Calendar Years," Final Rule, *Federal Register*, 55 no. 162, August 21, 1990, p. 34120.

15. National Petroleum Refiners Association, "U.S. Refining Industry Capability to Manufacture Ultra Low Sulfur Diesel Fuels," 1986, pp. 30 and 32. Operating costs were derived from NPRA's data.

16. EPA, "Regulation of Fuels and Fuel Additives: Fuel Quality Regulations for Highway Diesel Fuel Sold in 1993 and Later Calendar Years," Final Rule, p. 34121; EPA, "Regulation of Fuels and Fuel Additives; Fuel Quality Regulations for Highway Diesel Fuel Sold in 1993 and Later Calendar Years," Notice of Proposed Rulemaking, *Federal Register*, 54 no. 163, August 24, 1989, p. 35278.

17. EPA, "Regulation of Fuels and Fuel Additives: Fuel Quality Regulations for Highway Diesel Fuel

Sold in 1993 and Later Calendar Years," Final Rule, pp. 34121 and 34136.

18. "Bush Signs Clean Air Act Amendments, Predicts Benefits for All U.S. Citizens," *Environment Reporter*, 21 no. 30, November 23, 1990, p. 1387.

19. In an unpublished report, EPA estimated $24 billion in annual costs based on the provisions in Titles I, III, IV, V, and VIII; Dale W. Jorgenson and Peter J. Wilcoxen, "The Economic Impact of the Clean Air Act Amendments of 1990," *The Energy Journal*, 14 no. 1, p. 176. The clean gasoline program in Title II is estimated below to elicit significant compliance expenditures by the petroleum industry.

20. EPA, "Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Refueling Emission Regulations for Gasoline-Fueled Light-Duty Vehicles and Trucks and Heavy-Duty Vehicles," Final Agency Action, *Federal Register*, 57 no. 73, April 15, 1992, p. 13220.

21. *NRDC v. EPA*, CA DC, No. 92-1137, January 22, 1993.

22. EPA, "Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Refueling Emission Regulations for Light-Duty Vehicles and Heavy-Duty Vehicles," Notice of Public Hearing and Reopening of Comment Period on Proposed Onboard Vapor Recovery Regulations, *Federal Register*, 58 no. 101, May 27, 1993, p. 30731.

23. "EPA Announces Proposal on Clean Fuel Fleets," *Daily Environment Report*, no. 107, June 7, 1993, p. A-12.

24. Russell O. Jones and Michael H. Rusin (API), "Economic Comparisons of Refueling Vapor Control Policy Options," September 1991, pp. 2 and 4.

25. Richard C. Scherr, G. Allan Smalley Jr., and Michael E. Norman, "Clean Air Act complicates refinery planning," *Oil and Gas Journal*, 89 no. 21, May 27, 1991, p. 68.

26. Although the study accounts for differences in compliance costs with regard to controlling other types of emissions at refineries in attainment vs. nonattainment areas, such costs are not presented separately.

27. National Petroleum Council, *U.S. Petroleum Refining*, Appendix K (by Bechtel Corporation), forthcoming, Tables 3-12, 3-14, and 3-16. Cost estimates are multiplied by 1.2 in order to adjust (approximately) the costs from $1990 Gulf Coast to $1990 national estimates. September 20, 1993 letter from E.J. Swain (Bechtel Corporation) to Jody Perkins (API) confirms the appropriateness of this adjustment.

28. EPA, "Guidelines for Oxygenated Gasoline Credit Programs and Guidelines on Establishment of Control Periods Under Section 211(m) of the Clean Air Act as Amended," *Federal Register*, Notice of Availability, 57 no. 203, October 20, 1992, p. 47853; EPA, "Notice of Final Oxygenated Fuels Labeling Regulations Under Section 211(m) of the Clean Air Act as Amended," Final Rule, *Federal Register*, 57 no. 203, October 20, 1992, p. 47769.

29. EPA, "Regulation of Fuels and Fuel Additives; Standards for Reformulated and Conventional Gasoline," Supplemental Notice of Proposed Rulemaking, *Federal Register*, 57 no. 74, April 16, 1992, p. 13416.

30. EPA, "Regulation of Fuels and Fuel Additives: Standards for Reformulated Gasoline; Proposed Rule," Proposed Rule, *Federal Register*, 58 no. 37, February 26, 1993, p. 11722.

31. "EPA Considering Cuts in NOx Emissions in Phase II Reformulated Fuels Plan," *Daily Environment Report*, no. 62, April 2, 1993, p. A-10.

32. EPA, "Regulation of Fuels and Fuel Additives: Standards for Reformulated Gasoline; Proposed Rule," February 26, 1993, p. 11722.

33. EPA, "National Emission Standards for Hazardous Air Pollutants; Availability: Draft Schedule for the Promulgation of Emission Standards," Notice of Availability, *Federal Register*, 57 no. 186, September 24, 1992, p. 44147.

34. EPA, "National Emission Standards for Hazardous Air Pollutants for Source Categories; Organic Hazardous Air Pollutants from the Synthetic Organic Chemical Manufacturing Industry and Seven Other Processes," Proposed Rule, *Federal Register*, 57 no. 252, December 31, 1992, p. 62626.

35. Jeff Jones, Gary Marfin, and Lisa Hofmann, "An Analysis of Petroleum Industry Costs Associated with Air Toxics Amendments to the Clean Air Act," Interim Final Draft, October 17, 1989; February 21, 1990 memorandum from Michael Rusin and Lisa Hofmann (API) to Bob Strieter (API) and backup analyses.

36. Jody Perkins (API), "Revised Cost Estimates for Petroleum Industry Compliance with the Air Toxics Provisions of the Clean Air Act Amendments of 1990," September 21, 1993.

37. EPA, "Operating Permit Program," Final Rule, *Federal Register*, 57 no. 140, July 21, 1992, p. 32250.

38. National Petroleum Council, *U.S. Petroleum Refining*, Appendix K (by Bechtel Corporation), Tables 3-12, 3-14, and 3-16.

39. EPA, "Outer Continental Shelf Air Regulations," Final Rule, *Federal Register*, 57 no. 173, September 4, 1992, p. 40792.

40. Ibid, p. 40804. EPA did not state in the *Federal Register* notice the discount rate used or the number of years over which costs are annualized.

41. See, for example, Jones, Marfin, and Hofmann, "An Analysis of Petroleum Industry Costs," pp. 6-7.

42. EPA, "Technical Support Document for the Development of a VOC Rule for Marine Vessel Loading Operations," May 1992, p. 1-3.

43. Ibid, Table 3-21.

44. See, for example, Chapter 4 of EPA, "Technical Support Document."

45. See EPA, "Technical Support Document," Table 3-11 (i.e., costs associated with facility model #7B), and letter from V. Kenneth Leonard (API) to Susan R. Wyatt (EPA), December 5, 1990, and attachment.

46. EPA, "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions," Final Rule, *Federal Register*, 55 no. 61, March 29, 1990, p. 11798.

47. EPA, "Exemption of Petroleum-Contaminated Media and Debris From Underground Storage Tanks From RCRA Hazardous Waste Requirements: Proposed Rule," *Federal Register*, 58 no. 28, February 12, 1993, p. 8504.

48. EPA stated that since the proposed rule would save money, no regulatory impact analysis was necessary. EPA, "Exemption of Petroleum-Contaminated Media and Debris," Proposed Rule, February 12, 1993, p. 8512.

49. "Cost Savings, State Concerns Support Exempting Soil Polluted by Leaking Tanks," *Environment Reporter*, 23 no. 43, February 19, 1993, pp. 2711-2712.

50. API, Health and Environmental Affairs Department, "Estimated Impact of the Change in the Toxicity Characteristic on the Petroleum Industry," July 25, 1989, p. 18.

51. Letter from Martha A. Beauchamp (API) to Sylvia Lowrance (EPA), February 7, 1991, and attachment.

52. EPA, "Underground Storage Tanks Containing Petroleum -- Financial Responsibility Requirements and State Program Approval Objective," Final Rule, *Federal Register*, 53 no. 207, October 26, 1988, p. 43368. EPA's data indicate that service stations comprise 193,000 out of a total 468,000 UST facilities.

53. EPA, "Suspension of the Toxicity Characteristic Rule for Non-UST Petroleum Product-Contaminated Media and Debris," Proposed Rule, *Federal Register*, 57 no. 248, December 24, 1992, p. 61542.

54. Ibid, p. 61555.

55. EPA, "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristic; Hydrocarbon Recovery Operations," Final Rule, *Federal Register*, 56 no. 63, April 2, 1991, p. 13406.

56. EPA, "Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities," Proposed Rule, *Federal Register*, 55 no. 145, July 27, 1990, p. 30798. EPA also plans to propose a separate rule governing ground-water cleanups; no cost estimates are yet available for this.

57. "SAB Economist Says Reviews of RCRA Rule, Contingent Valuation Study Should Merge," *Daily Environment Report*, no. 83, May 3, 1993, p. A-6.

58. "States Urge EPA to Repropose RCRA Corrective Action Rule," *Daily Environment Report*, no. 72, April 16, 1993, p. A-14.

59. EPA, "Corrective Action Management Units and Temporary Units; Corrective Action Provisions Under Subtitle C," Final Rule, *Federal Register*, 58 no. 29, February 16, 1993, p. 8658.

60. "Final Rule on Corrective Action Units Removes Barrier to Bioremediation, EPA Says," *Environment Reporter*, 23 no. 43, February 19, 1993, p. 2707.

61. EPA, "Draft Regulatory Impact Analysis for the Final Rulemaking on Corrective Action for Solid Waste Management Units: Proposed Methodology for Analysis," March 1993, p. 5-25.

62. Ibid, p. ES-3.

63. Ibid, Exhibit 5-6.

64. EPA, "Draft Regulatory Impact Analysis," p. 5-17.

65. This is consistent with EPA's annualization of total costs. See EPA, "Draft Regulatory Impact Analysis," p. 5-25.

66. Based on the SIC codes of sample facilities used to derive EPA's cost estimates; see EPA, "Draft Regulatory Impact Analysis," Exhibit 5-9.

67. Ibid, Exhibit 5-7.

68. Tischler/Kocurek, "Corrective Action Cost Study for a Generic Petroleum Refinery," for API, August 4, 1993. Costs estimated are for Scenarios A and B.

69. "Industry Praises Corrective Action Proposal, But States, Others Say Cleanups Will be Delayed," *Environment Reporter*, 21 no. 32, December 7, 1990, pp. 1523-1524.

70. Results of the University of Tennessee study are reported in Hazardous Waste Cleanup Project, "Sticker Shock," p. 7. For details, see the study itself: Russell, Colglazier and English, *Hazardous Waste Remediation: The Task Ahead*, Hazardous Waste Remediation Project, Waste Management Research and Education Institute, University of Tennessee, December 1991.

71. EPA, "Land Disposal Restrictions for Third Third Scheduled Wastes," Final Rule, *Federal Register*, 55 no. 106, June 1, 1990, p. 22520.

72. EPA proposed requirements for no migration petitions in 1992: EPA, "Land Disposal Restrictions 'No Migration' Variances," Proposed Rule and Notice of Availability, *Federal Register*, 57 no. 155, August 11, 1992, p. 35940. EPA plans to finalize these requirements in 1994.

73. *Chemical Waste Management v. EPA*, 976, F.2d 2 (1992).

74. API, "Comments of the American Petroleum Institute on the Land Disposal Restrictions for Third Third Scheduled Wastes, Response to Court Decision: Docket No. F-93-TTCA-FFFFF," March 4, 1993, p. 76.

75. EPA, "Hazardous Waste Management Systems: Identification and Listing of Hazardous Waste; CERCLA Hazardous Substance Designation -- Petroleum Refinery Primary and Secondary Oil/Water/Solids Separation Sludge Listings (F037 and F038)," Final Rule, *Federal Register*, 55 no. 213, November 2, 1990, p. 46354.

76. EPA, "Land Disposal Restrictions for Newly Listed Wastes and Hazardous Debris," Final Rule, *Federal Register* 57 no. 160, August 18, 1992, p. 37194.

77. Ibid, p. 37260.

78. See API, "Comments on Proposed Land Disposal Restrictions for Newly Listed Wastes and Contaminated Debris," Comments on Proposed Rule, EPA Docket No. F-91-CD2P-FFFFF, February 24, 1992, especially Appendix B: Costs of Proposed Land Disposal Restrictions for Primary Sludge.

79. EPA, "Oil and Gas Extraction Point Source Category; Offshore Subcategory Effluent Limitations Guidelines and New Source Performance Standards," Final Rule, *Federal Register*, 58 no. 41, March 4, 1993, p. 12454.

80. Ibid, p. 12492.

81. Ibid, pp. 12493-12494. The estimates for produced water are summed from EPA's component estimates.

82. EPA, "Final NPDES General Permit for the Western Gulf of Mexico Outer Continental Shelf," Issuance of a Final NPDES Permit, *Federal Register*, 57 no. 224, November 19, 1992, p. 54642.

83. Ibid.

84. *API v. EPA*, 5th Circuit U.S. Court of Appeals, for the 5th Circuit, New Orleans.

85. EPA, "Proposed Modification of the NPDES General Permit for the Western Portion of the Outer Continental Shelf (OCS) of the Gulf of Mexico (GMG290000)," Notice of Proposed NPDES General Permit Modification, *Federal Register*, 58 no. 148, August 4, 1993, p. 41474.

86. Gruy Engineering Corporation, "A Study of the Economic Impacts of Produced Water Effluent Guidelines for the United States Offshore Area," for API, November 1990, Table 1.

87. EPA, "Proposed NPDES General Permits for Produced Water and Produced Sand Discharges From the Oil and Gas Extraction Point Source Category To Coastal Waters in Louisiana and Texas," Notice of Draft NPDES General Permit, *Federal Register*, 57 no. 246, December 22, 1992, p. 60926.

88. Ibid, p. 60934.

89. Ibid, p. 60936.

90. See EPA, "Proposed NPDES General Permit for Coastal Waters of Texas," Notice of Draft NPDES General Permit, *Federal Register*, 55 no. 110, June 7, 1990, p. 23378. See also EPA, "Proposed NPDES General Permit for the Coastal Waters of Louisiana," Notice of Draft NPDES General Permit, *Federal Register*, 55 no. 110, June 7, 1990, p. 23348.

91. EPA, "Proposed NPDES General Permit for Coastal Waters of Texas," June 7, 1990, p. 23381; EPA, "Proposed NPDES General Permit for the Coastal Waters of Louisiana," June 7, 1990, p. 23360.

92. ICF Resources Incorporated, *Potential Cumulative Impacts of Environmental Regulatory Initiatives on U.S. Crude Oil Exploration and Development*, vol. 2: Final Report, for U.S. Department of Energy, December 1990, pp. II-19, A-69, and A-72.

93. Gruy Engineering Corporation, "Midcourse Evaluation Economics Study (Phases I, II, and III) Estimated Costs for Certain Proposed Revisions in the Underground Injection Control Regulations for Class II Injection Wells," June 9, 1989.

94. ICF Resources Incorporated, *Potential Cumulative Impacts*, pp. II-18 and A-27 to A-50.

95. EPA, "Effluent Guidelines Plan," Notice of Effluent Guidelines Plan, *Federal Register*, 57 no. 174, September 8, 1992, pp. 41000-41001.

96. National Petroleum Council, *U.S. Petroleum Refining*, Appendix K (by Bechtel Corporation), Tables 4-2, 4-4, and 4-5. Cost estimates are multiplied by 1.2 in order to adjust (approximately) the costs from $1990 Gulf Coast to $1990 national estimates. September 20, 1993 letter from E.J. Swain (Bechtel) to Jody Perkins (API) confirms the appropriateness of this adjustment.

97. EPA, "Proposed Water Quality Guidance for the Great Lakes System," Proposed Rule, *Federal Register*, 58 no. 72, April 16, 1993, p. 20802.

98. Ohio Petroleum Council, "Survey of Estimated Costs of Compliance with the Great Lakes Water Quality Initiative," January 15, 1993, p. 1.

99. See "Hill Lawmakers Want to Include Regional Provisions in Clean Water Rewrite," *Daily Environment Report*, no. 149, August 5, 1993, pp. A-5 to A-7.

100. Russell O. Jones, "Estimated Costs and Benefits of Retrofitting Aboveground Petroleum Industry Storage Tanks with Release Prevention Barriers," API Research Study #065, September 1992, p. 11. This citation summarizes a survey of ASTs by Entropy Limited.

101. EPA is conducting roundtable discussions on various AST issues during the summer and fall of 1993.

102. In a notice of proposed rulemaking (EPA, "Oil Pollution Prevention; Nontransportation-related Onshore and Offshore Facilities," Proposed Rule, *Federal Register*, 56 no. 204, October 22, 1991, p. 54612), EPA announced its decision to address new components to the current SPCC program in two phases (i.e., two separate rulemakings). Phase One would cover additional facility design, operation, and maintenance requirements relating to spill prevention. Phase Two would address facility-specific contingency/response plan requirements as mandated by the Oil Pollution Act of 1990.

103. EPA, "Oil Pollution Prevention; Nontransportation-related Onshore and Offshore Facilities," October 22, 1991, p. 54612.

104. ABB Environmental Services, Inc., *The OPA Liner Study*, for EPA, January 1992 draft, Exhibit 17.

105. EPA, "Oil Pollution Prevention; Nontransportation-related Onshore and Offshore Facilities," October 22, 1991, p. 54628.

106. ABB Environmental Services, Inc., *The OPA Liner Study*, Exhibit 17. Petroleum production, refining, transportation, and marketing facilities comprise 266,000 facilities out of EPA's 505,000 total.

107. Gruy Engineering Corporation, "Assessment of the Economic Impact of Certain Anticipated SPCC Regulations Pertaining to Aboveground Storage Tanks," for API, September 1990.

108. Jones, "Estimated Costs and Benefits of Retrofitting Aboveground Petroleum Industry Storage Tanks," p. 29.

109. U.S. Coast Guard, DOT, "Double Hull Standards for Tank Vessels Carrying Oil," Proposed Rule, *Federal Register*, 55 no. 234, December 5, 1990, p. 50192.

110. U.S. Coast Guard, "Double Hull Standards for Vessels Carrying Oil in Bulk," Interim Final Rule, *Federal Register*, 57 no. 156, August 12, 1992, p. 36222.

111. Per Fredrick Scheer, U.S. Coast Guard, July 8, 1993. The present value estimate is based on the analysis contained in Temple, Barker & Sloane, Inc., *Interim Regulatory Impact Analysis for the Oil Pollution Act of 1990, Titles IV and V*, for U.S. Coast Guard, October 28, 1991.

112. U.S. Coast Guard, DOT, "Financial Responsibility for Water Pollution (Vessels)," Proposed Rule, *Federal Register*, 56 no. 187, September 26, 1991, p. 49006.

113. U.S. Coast Guard, DOT, "Preliminary Regulatory Impact Analysis: Financial Responsibility for Water Pollution (Vessels)," July 12, 1993, Table 6.

114. About 7.6 million barrels were imported daily in 1991, according to the Coast Guard report (Table 4). Multiplying 7.6 million barrels by 365 yields the 2.774 billion barrel total.

115. Mercer Management Consulting, Inc., "The Economic Impact of Implementing the Coast Guard's Proposed Rule on Financial Responsibility," August 1992, Executive Summary.

116. These guidelines were later amended. See U.S. Coast Guard, Navigation and Inspection Circular 8-92, Change 2, January 15, 1993.

117. U.S. Coast Guard, "Vessel Response Plans," Interim Final Rule, *Federal Register*, 58 no. 23, February 5, 1993, p. 7376.

118. Ibid, p. 7418 and Mercer Management Consulting, "Interim Regulatory Impact Analysis for Vessel Response Plans," prepared for U.S. Department of Transportation, January 1993, p. 74.

119. See U.S. Coast Guard, "Vessel Response Plans," February 5, 1993, p. 7418 and Mercer Consulting Management, "Interim Regulatory Impact Analysis," p. 74.

120. See the discussion in U.S. Coast Guard, "Vessel Response Plans," February 5, 1993, p. 7418 regarding estimated numbers of fishing and towing vessels to be affected by the interim rule.

121. Ibid, and Mercer Consulting Management, "Interim Regulatory Impact Analysis," p. 93.

122. U.S. Coast Guard, Navigation and Inspection Circular No. 7-92, September 15, 1992.

123. U. S. Coast Guard, "Response Plans for Marine Transportation-Related Facilities," Interim Final Rule, *Federal Register*, 58 no. 23, February 5, 1993, p. 7330.

124. Ibid, p. 7348.

125. Ibid, p. 7350.

126. EPA, "Oil Pollution Prevention; Non-Transportation-Related Onshore Facilities," Proposed

Rule, *Federal Register*, 58 no. 30, February 17, 1993, p. 8824.

127. Ibid, p. 8845.

128. See ABB Environmental Services, Inc., *The OPA Liner Study*, Exhibit 17. Petroleum industry facilities comprise 57,600 to 109,200 of the 65,900 to 127,900 facilities with AST capacity of 42,001 gallons or more.

129. Research and Special Programs Administration, DOT, "Response Plans for Onshore Oil Pipelines," Interim Final Rule with Request for Comments, *Federal Register*, 58 no. 2, January 5, 1993, p. 244.

130. "RSPA Issues Interim Final Rule on Emergency Plans for Oil Releases," *Daily Environment Report*, no. 251, December 31, 1992, p. A-3.

131. Research and Special Programs Administration, "Response Plans for Onshore Oil Pipelines," January 5, 1993, pp. 252-253.

132. U.S. Coast Guard, DOT, "Discharge Removal Equipment for Vessels Carrying Oil," Proposed Rule, *Federal Register*, 57 no. 189, September 29, 1992, p. 44912.

133. Ibid, p. 44918.

134. See, for example, "Browner Announces Plan to Expand TRI To Cover More Chemicals, Industries," *Daily Environment Report*, no. 100, May 26, 1993, pp. A-1 and A-2.

135. EPA, "Toxic Chemical Release Reporting: Pollution Prevention Information," Proposed Rule, *Federal Register*, 56 no. 186, September 25, 1991, p. 48475.

136. "Toxic Release Inventory Form not Expected to Change Until 1994," *Daily Environment Report*, no. 52, March 19, 1993, p. AA-1.

137. EPA, "Chemicals; Toxic Chemical Release Reporting; Community Right-To-Know; Proposed Significant New Use Rule," Proposed Rule, *Federal Register*, 57 no. 174, September 8, 1992, p. 41020.

138. "Browner Announces Plan to Expand TRI," p. A-1.

139. Dames & Moore, "Evaluation of Costs and Other Impacts Imposed on the U.S. Oil and Gas Exploration and Production Industry by Implementation of Either Right-to-Know-More Legislation or SARA 313 Reporting by Regulation," for API, June 11, 1993, p. 1-1.

140. Ibid, pp. 4-6 and 4-7.

141. Jones, Marfin, and Hofmann, "An Analysis of Petroleum Industry Costs"; February 21, 1990 memorandum from Michael Rusin and Lisa Hofmann (API) to Bob Strieter (API) and backup analyses.

142. Perkins, "Revised Cost Estimates."

143. See Clean Air Act as amended, §112(n)(6).

144. "Congress to Receive Hydrogen Fluoride Hazards Reduction Report by Sept. 30," *Daily Environment Report*, no. 132, July 13, 1993, p. A-3.

145. National Petroleum Council, *U.S. Petroleum Refining*, Appendix K (by Bechtel Corporation), Tables 6-2, 6-4, and 6-6. Cost estimates are multiplied by 1.2 in order to adjust (approximately) the costs from $1990 Gulf Coast to $1990 national estimates. September 20, 1993 letter from E.J. Swain (Bechtel) to Jody Perkins (API) confirms the appropriateness of this adjustment.

146. James E. Satterfield, "A Tale of Sound and Fury: The Environmental Record of the 102nd Congress," *Environmental Law Reporter: News and Analysis*, XXIII no. 1, January 1993, p. 10021.

147. ICF Resources Incorporated, *Potential Cumulative Impacts*, pp. II-17 and A-4 to A-26.

148. Gruy Engineering Corporation, "Estimates of RCRA Reauthorization Economic Impacts on the Petroleum Extraction Industry," for API, July 20, 1991. See especially p. 1 and Table 2.

149. See, for example, "Congress Urged to Create New Program to Regulate Non-hazardous Industrial Waste," *Environment Reporter*, 22 no. 21, September 20, 1991, pp. 1341-1342.

150. Russell O. Jones and Jody M. Perkins, "RCRA Economic Impact Analysis: Refinery Nonhazardous Wastewater Surface Impoundments," API Research Study #072, September 1993.

151. National Petroleum Council, *U.S. Petroleum Refining*, Appendix K (by Bechtel Corporation), Tables 4-2, 4-4, and 4-5. Individual cost estimates are summed, and the totals are multiplied by 1.2 in order to adjust (approximately) the costs from $1990 Gulf Coast to $1990 national estimates. September 20, 1993 letter from E.J. Swain (Bechtel) to Jody Perkins (API) confirms the appropriateness of this adjustment.

152. Claudia Copeland (Congressional Research Service, Library of Congress), "Funding Water Quality Programs: Revenues for a National Clean Water Investment Corporation," July 10, 1992, pp. 3 and 56.

153. "Construction, Leak-Detection Standards for Tanks would be Set Under Senate Bill," *Daily Environment Report*, no. 34, February 23, 1993, p. A-2.

154. Gruy Engineering Corporation, "Assessment of the Economic Impact of Certain Anticipated SPCC Regulations."

155. Derived from data on p. 2 of Gruy Engineering Corporation, "Assessment of the Economic Impact of Certain Anticipated SPCC Regulations." The estimate of annual costs is an annualization of certification compliance costs occurring every 3 years.

156. See, for example, (1) David E. Gushee (Congressional Research Service, Library of Congress), "Alternative Fuels Promises and Pitfalls," Statement to National Conference of State Legislatures, 1991 Annual Meeting, Orlando, Florida, August 11, 1991, and (2) W. David Montgomery and James L. Sweeney (Charles River Associates Incorporated), "Final Report: Mandates for Alternative Fuels: A Policy Analysis," for API, August 1991.

157. American Bar Association, "Update: Implementing the 1990 Clean Air Act," for American Law Network Satellite Seminar, February 11, 1993.

158. EPA, "Clean Fuel Fleet Credit Programs, Transportation Control Measure Exemption, and Related Provisions," Final Rule, *Federal Register*, 58 no. 38, March 1, 1993, p. 11888.

159. EPA, "Clean Fuel Fleet Emission Standards, Conversions, and General Provisions and Amended Heavy-Duty Averaging, Banking, and Trading Credit Accounting Regulations," Proposed Rule, *Federal Register*, 58 no. 110, June 10, 1993, p. 32474.

160. EPA, "Fuels and Fuel Additives Registration Regulations," Notice of Proposed Rulemaking, *Federal Register*, 57 no. 73, April 15, 1992, p. 13168.

161. API, "Comments of the American Petroleum Institute on U.S. EPA's Proposed Fuels and Fuel Additives Registration Regulations," EPA Air Docket No. A-90-07, July 7, 1992, p. 52. As noted by API, however, this is considerably higher than costs estimated by EPA for conducting biological assays.

162. EPA, "Semiannual Regulatory Agenda," April 26, 1993, p. 25069.

163. EPA, "Volatility Regulations for Gasoline and Alcohol Blends," Final Rule, *Federal Register*, 58 no. 50, March 17, 1993, p. 14476.

164. *American Petroleum Institute v. Environmental Protection Agency*, No. 93-13413 (filed May 14, 1993).

165. EPA, "List of Regulated Substances and Thresholds for Accidental Release Prevention; Requirements for Petitions under Section 112(r) of the Clean Air Act as Amended," Proposed Rule, *Federal Register*, 58 no. 11, January 19, 1993, p. 5102.

166. "EPA Proposes List and Thresholds for Chemical Accident Prevention," *Daily Environment Report*, no. 14, January 25, 1993, pp. A-3 and A-4.

167. EPA, "Request for Nominations for Essential Use Exemptions for Halons 1211, 1301, and 2402," Notice, *Federal Register*, 58 no. 20, February 2, 1993, p. 6786.

168. Satterfield, "A Tale of Sound and Fury," p. 10021.

169. "Senate RCRA Legislation Could Cost up to $46 Billion per Year, EPA Estimates," *Environment Reporter*, 23 no. 12, July 17, 1992, pp. 888-889.

170. Tischler/Kocurek, "Corrective Action Cost Study." These cost estimates are calculated by subtracting costs under Scenario B from costs under Scenario C.

171. Disposal: EPA, "Hazardous Waste Management System; General; Identification and Listing of Hazardous Waste; Used Oil," Final Rule, *Federal Register*, 57 no. 98, May 20, 1992, p. 21524. Recycling and Management: EPA, "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Recycled Used Oil Management Standards," Final Rule, *Federal Register*, 57 no. 176, September 10, 1992, p. 41566.

172. For example, *Safety-Kleen v EPA*, U.S. Court of Appeals, D.C. Circuit, No. 92-1629; and *NRDC v EPA*, U.S. Court of Appeals, D.C. Circuit, No. 92-1371.

173. EPA, "Land Disposal Restrictions for Newly Identified and Listed Hazardous Wastes and Hazardous Soil," Proposed Rule, *Federal Register*, 58 no. 176, September 14, 1993, p. 48092.

174. EPA used the cost estimate of $1,700 per ton when estimating costs associated with land disposal restrictions for petroleum refining primary sludges. See EPA, "Land Disposal Restrictions for Newly Listed Wastes and Contaminated Debris," Proposed Rule, *Federal Register*, 57 no. 6, January 9, 1992, p. 1007.

175. *Shell Oil Co. v. EPA*, 950 F.2d 751 (D.C. Cir. 1991).

176. EPA considered such an option, as suggested by a petition from the Chemical Manufacturers Association, in its proposed rule: EPA, "Hazardous Waste Management System; Identification and Listing of Hazardous Waste," Proposed Rule, Tentative Response to Chemical Manufacturers Association Petition, and Request for Comments, *Federal Register*, 57 no. 98, May 20, 1992, p. 21450.

177. Ibid, p. 21454.

178. EPA, "Hazardous Waste Management System; Definition of Hazardous Waste; 'Mixture' and 'Derived-From' Rules," *Federal Register*, 57 no. 211, October 30, 1992, p. 49278.

179. "States, Industry Favor Site-Specific Option for Regulating Contaminated Media," *Daily Environment Report*, no. 73, April 19, 1993, pp. A-2 and A-3.

180. EPA, "Hazardous Waste Management System," Proposed Rule, May 20, 1992, pp. 21500-21502.

181. EPA, "Semiannual Regulatory Agenda," April 26, 1993, p. 25044.

182. EPA, "Hazardous Waste Treatment, Storage, and Disposal Facilities; Organic Air Emission Standards for Tanks, Surface Impoundments, and Containers," Proposed Rule, *Federal Register*, 56 no. 140, July 22, 1991, p. 33490.

183. EPA, "Guidelines Establishing Test Procedures for the Analysis of Pollutants; Identification and Listing of Hazardous Waste; Test Methods," Proposed Rule and Request for Comments, *Federal Register*, 56 no. 128, July 3, 1991, p. 30519.

184. See 40 CFR 260.10.

185. Russell Jones (API), "Estimated Share of Superfund Taxes Paid by the Petroleum Industry," July 12, 1993.

186. Hazardous Waste Cleanup Project, "Sticker Shock: Recognizing the Full Cost of Superfund," June 1993, p. iii.

187. EPA, "National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges," Final Rule, *Federal Register*, 55 no. 222, November 16, 1990, p. 47990.

188. EPA, "EPA Releases Final Storm Water Discharge General Permit," press release, September 3, 1992, p. 2.

189. For example, a court decision in June 1992 (*NRDC v. EPA*, Ninth Circuit Court) invalidated EPA's exemption of construction activities involving less than five acres; many production facilities fit into this category. In addition, in a recent court case some API members and others have challenged an EPA interpretation that would require permits for construction operations at exploration and production sites that disturb more than 5 acres of land.

190. For industrial facilities: EPA, "Final NPDES General Permits for Storm Water Discharges Associated with Industrial Activity," Notice of Final NPDES General Permits, *Federal Register*, 57 no. 175, September 9, 1992, p. 41236; EPA, "Final NPDES General Permits for Storm Water Discharges Associated with Industrial Activity," Notice of Final NPDES General Permits, *Federal Register*, 57 no. 187, September 25, 1992, p. 44438. For construction sites: EPA, "Final NPDES General Permits for Storm Water Discharges from Construction Sites," Notice of Final NPDES General Permits, *Federal Register*, 57 no. 187, September 25, 1992, p. 44412.

191. EPA, "Final NPDES General Permits for Storm Water Discharges Associated with Industrial Activity," September 9, 1992, pp. 41252-41253.

192. Per Don Olson, EPA, October 15, 1991.

193. "EPA Orders Injection Well Closures at 1,800 Gas Stations in 49 States," *Ground Water Monitor*, 7 no. 15, July 24, 1991, p. 141. According to Don Olson, EPA, the settlements described in this article were proposed settlements, but there were no significant changes in the technical provisions in the final settlements. The API guidelines are published in API, "Handling Water Discharges From Automotive Service Facilities Located at Petroleum Marketing Operations," API Recommended Practice 1633, first edition, January 1992.

194. "EPA Orders Injection Well Closures," p. 141.

195. Robert Anderson and Mark Rockel, "Economic Valuation of Wetlands," API Discussion Paper #065, April 1991, pp. 55-56.

196. Research and Special Programs Administration, DOT, "Specifications for Tank Car Tanks," Advance Notice of Proposed Rulemaking, *Federal Register*, 55 no. 94, May 15, 1990, p. 20242.

197. Minerals Management Service, DOI, "Oil Spill Financial Responsibility for Offshore Facilities Including State Submerged Lands and Pipelines," Advanced Notice of Proposed Rulemaking, *Federal Register*, 58 no. 163, August 25, 1993, p. 44797.

198. "Proposed Rule Will Increase Financial Liability for Offshore Oil Facilities," *Daily Environment Report*, no. 163, August 25, 1993, p. A-1.

199. DOI, "Natural Resource Damage Assessments," Proposed Rule, *Federal Register*, 56 no. 82, April 29, 1991, p. 19752.

200. "DOI to Reopen Comments Period on Resource Damage Assessments," *Daily Environment Report*, April 13, 1993, pp. A-1 and A-2.

201. See NOAA, "Natural Resource Damage Assessments," Advance Notice of Proposed Rulemaking, *Federal Register*, 55 no. 250, December 28, 1990, p. 53478.

202. NOAA, "Natural Resource Damage Assessments," Advance Notice of Proposed Rulemaking, *Federal Register*, 55 no. 250, December 28, 1990, p. 53478; NOAA, "Natural Resource Damage Assessments," Advance Notice of Proposed Rulemaking, *Federal Register*, 57 no 50, March 13, 1992, p. 8964; NOAA, "Natural Resource Damage Assessments Under the Oil Pollution Act of 1990," Advance Notice of Proposed Rulemaking, Extension of Comment Period and Release of Contingent Valuation Methodology Report, *Federal Register*, 58 no. 10, January 15, 1993, p. 4601.

203. NOAA, "Natural Resource Damage Assessments," January 15, 1993, p. 4602.

204. "Panel Backs Use of Contingent Valuation, NOAA Says in Advance Notice of Rule-Making," *Environment Reporter*, 23 no. 39, January 22, 1993, p. 2490.

205. See Bradley M. Marten and Cestjon L. McFarland, "Litigating CERCLA Natural Resource Damage Claims," *Environment Reporter*, 22 no. 12, July 19, 1991, p. 670.

206. Ibid.

207. "Federal Judge Accepts $1 Billion Settlement, Ends Two-Year Litigation in Exxon Oil Spill," *Environment Reporter*, 22 no. 24, October 11, 1991, pp. 1533-1534.

208. "DOI to Reopen Comments Period," p. A-1.

209. Richard T. Carson, Robert C. Mitchell, W. Michael Hanemann, Raymond J. Kopp, Stanley Preser, and Paul A. Ruud, "A Contingent Valuation Study of Lost Passive Use Values Resulting From the Exxon Valdez Oil Spill," A Report to the Attorney General of the State of Alaska, November 10, 1992, p. 5-123.

210. "Senate Water Act Reauthorization Announced; Non-point Source, Toxics Provisions Included," *Environment Reporter*, 24 no. 7, June 18, 1993, p. 308.

211. National Petroleum Council, *The Potential for Natural Gas in the United States: Source and Supply*, vol. II, December 1992, p. 262.

212. "@Risk" software was used to run the simulation.

213. This is equivalent to a standard deviation of one-half the difference between the mean and $1.67 billion -- $297 million.

214. Covariances between estimates for different regulations were assumed to be zero.

215. It should be noted that although API conducted surveys to gather environmental spending information from 1973 to 1984 and again beginning in 1990, some methods used in the later surveys differ from those used in the 1970s and 1980s.

216. EPA lists the new and potential regulations it included in its analysis in Table 2-3 in EPA, *Environmental Investments: The Cost Of A Clean Environment*, November 1990.

217. One such study was completed in 1980 for EPA. This study found that cost estimates made in the 1970s tended to over-estimate actual costs. As EPA notes, however, cost estimation may have improved during the 1980s. See EPA, *Environmental Investments*, p. 8-8.

218. See, for example, Jody Perkins, "An Historical Overview of Solid Waste Management in the Petroleum Industry," API Discussion Paper #062, October 1990.

219. Jorgenson and Wilcoxen, "The Economic Impact of the Clean Air Act Amendments of 1990," pp. 163 and 178.

220. These estimates are based on EPA's cost estimates, which, apparently, exclude costs associated with Title II provisions. See ibid, p. 176.

221. For a discussion of such an analysis, see, for example, Michael Rusin, Robert C. Anderson, and Thomas J. Lareau, "Managing the Environment: A Review of Present Programs and Their Goals and Methods," API Discussion Paper #057, February 1989, pp. 68-75.

222. Perkins, "Costs to the Petroleum Industry."

223. For a listing of availability requirements by area, see EPA, "Guidelines for Oxygenated Gasoline Credit Programs," October 20, 1992, Table 1, p. 47855.

224. EPA, "Regulation of Fuels and Fuel Additives: Standards for Reformulated and Conventional Gasoline," April 16, 1992, p. 13419.

225. EPA, *Environmental Investments*, p. 1-14.

226. "National Income and Product Accounts Tables," *Survey of Current Business*, 72 no. 7, July 1992, Table 7.3.

227. EPA, *Environmental Investments*, p. 2-1.

Major References

Air

American Bar Association, "Update: Implementing the 1990 Clean Air Act," for American Law Network Satellite Seiminar, February 11, 1993.

API, "API Comments on EPA's Draft Regulatory Impact Analysis on the Control of Gasoline Volatility and Evaporative Hydrocarbon Emissions: Attachment 2, Costs of RVP Reductions," February 5, 1988.

_____, "Supplement to the American Petroleum Institute's Petition for Reconsideration of the National Emission Standards for Hazardous Air Pollutants for Benzene Waste Operations," May 30, 1991.

_____, "Comments of the American Petroleum Institute on U.S. EPA's Proposed Fuels and Fuel Additives Registration Regulations," EPA Air Docket No. A-90-07, July 7, 1992.

Auto/Oil Air Quality Improvement Research Program, "Estimated Costs of Modifying Gasoline Properties," Economics Bulletin No. 2, January 1992.

"Bush Signs Clean Air Act Amendments, Predicts Benefits for All U.S. Citizens," *Environment Reporter*, 21 no. 30, November 23, 1990, p. 1387.

"Congress to Receive Hydrogen Fluoride Hazards Reduction Report by Sept. 30," *Daily Environment Report*, no. 132, July 13, 1993, p. A-3.

"Draft EPA Rule Outlines Requirements for Enhanced Monitoring of Emissions," *Environment Reporter*, 23 no. 44, February 26, 1993, pp. 2827-2828.

DRI/McGraw Hill, "Assessing the Economic Effects of Northeastern States Adoption: California's Low Emission Vehicle Program -- Volume II -- Appendices," for API, November 1991.

"EIA Report Says Oxygenate Demand is Less than Expected, Supplies are Sufficient," *New Fuels Report*, March 1, 1993, pp. 15-16.

EPA, "Regulation of Fuels and Fuel Additives; Fuel Quality Regulations for Highway Diesel Fuel Sold in 1993 and Later Calendar Years," Notice of Proposed Rulemaking, *Federal Register*, 54 no. 163, August 24, 1989, pp. 35276-35299.

_____, "National Emission Standards for Hazardous Air Pollutants; Benzene Emissions from Chemical Manufacturing Process Vents, Industrial Solvent Use, Benzene Waste Operations, Benzene Transfer Operations, and Gasoline Marketing System," Final Rule, *Federal Register*, 55 no. 45, March 7, 1990, pp. 8292-8361.

_____, "Volatility Regulations for Gasoline and Alcohol Blends Sold in Calendar Years 1992 and Beyond," Final Rule, *Federal Register*, 55 no. 112, June 11, 1990, pp. 23658-23667.

_____, "Regulation of Fuels and Fuel Additives: Fuel Quality Regulations for Highway Diesel Fuel Sold in 1993 and Later Calendar Years," Final Rule, *Federal Register*, 55 no. 162, August 21, 1990, pp. 34120-34151.

_____, "National Emission Standards for Hazardous Air Pollutants; Benzene Waste Operations," Final Rule, *Federal Register*, 57 no. 44, March 5, 1992, pp. 8012-8016.

_____, "Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Refueling Emission Regulations for Gasoline-Fueled Light-Duty Vehicles and Trucks and Heavy-Duty Vehicles," Final Agency Action, *Federal Register*, 57 no. 73, April 15, 1992, pp. 13220-13231.

_____, "Fuels and Fuel Additives Registration Regulations," Notice of Proposed Rulemaking, *Federal Register*, 57 no. 73, April 15, 1992, pp. 13168-13217.

_____, "Regulation of Fuels and Fuel Additives; Standards for Reformulated and Conventional Gasoline," Supplemental Notice of Proposed Rulemaking, *Federal Register*, 57 no. 74, April 16, 1992, pp. 13416-13495.

_____, "Technical Support Document for the Development of a VOC Rule for Marine Vessel Loading Operations," May 1992.

_____, "Operating Permit Program," Final Rule, *Federal Register*, 57 no. 140, July 21, 1992, pp. 32250-32312.

_____, "Outer Continental Shelf Air Regulations," Final Rule, *Federal Register*, 57 no. 173, September 4, 1992, pp. 40792-40818.

_____, "National Emission Standards for Hazardous Air Pollutants; Availability: Draft Schedule for the Promulgation of Emission Standards," Notice of Availability, *Federal Register*, 57 no. 186, September 24, 1992, pp. 44147-44159.

_____, "Notice of Final Oxygenated Fuels Labeling Regulations Under Section 211(m) of the Clean Air Act as Amended," Final Rule, *Federal Register*, 57 no. 203, October 20, 1992, pp. 47769-47772.

_____, "Guidelines for Oxygenated Gasoline Credit Programs and Guidelines on Establishment of Control Periods Under Section 211(m) of the Clean Air Act as Amended," Notice of Availability, *Federal Register*, 57 no. 203, October 20, 1992, pp. 47853-47855.

_____, "National Emission Standards for Hazardous Air Pollutants for Source Categories; Organic Hazardous Air Pollutants from the Synthetic Organic Chemical Manufacturing Industry and Seven Other Processes," Proposed Rule, *Federal Register*, 57 no. 252, December 31, 1992, pp. 62608-62798.

_____, "National Emission Standards for Hazardous Air Pollutants; Benzene Waste Operations," Final Rule, *Federal Register*, 58 no. 4, January 7, 1993, pp. 3072-3105.

_____, "List of Regulated Substances and Thresholds for Accidental Release Prevention; Requirements for Petitions under Section 112(r) of the Clean Air Act as Amended," Proposed Rule, *Federal Register*, 58 no. 11, January 19, 1993, pp. 5102-5125.

_____, "Request for Nominations for Essential Use Exemptions for Halons 1211, 1301, and 2402," Notice, *Federal Register*, 58 no. 20, February 2, 1993, pp. 6786-6788.

_____, "Regulation of Fuels and Fuel Additives: Standards for Reformulated Gasoline; Proposed Rule," Proposed Rule, *Federal Register*, 58 no. 37, February 26, 1993, pp. 11722-11763.

_____, "Clean Fuel Fleet Credit Programs, Transportation Control Measure Exemption, and Related Provisions," Final Rule, *Federal Register*, 58 no. 38, March 1, 1993, pp. 11888-11907.

_____, "Volatility Regulations for Gasoline and Alcohol Blends," Final Rule, *Federal Register*, 58 no. 50, March 17, 1993, pp. 14476-14490.

_____, "National Emission Standards for Hazardous Air Pollutants, Benzene Waste Operations," Advance Notice of Proposed Rulemaking, *Federal Register*, 58 no. 54, March 23, 1993, pp. 15457-15461.

_____, "Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Refueling Emission Regulations for Light-Duty Vehicles and Heavy-Duty Vehicles," Notice of Public Hearing and Reopening of Comment Period on Proposed Onboard Vapor Recovery Regulations, *Federal Register*, 58 no. 101, May 27, 1993, pp. 30731-30741.

_____, "Clean Fuel Fleet Emission Standards, Conversions, and General Provisions and Amended Heavy-Duty Averaging, Banking, and Trading Credit Accounting Regulations," Proposed Rule, *Federal Register*, 58 no. 110, June 10, 1993, pp. 32474-32503.

"EPA Announces Proposal on Clean Fuel Fleets," *Daily Environment Report*, no. 107, June 7, 1993, p. A-12.

"EPA Considering Cuts in NOx Emissions in Phase II Reformulated Fuels Plan," *Daily Environment Report*, no. 62, April 2, 1993, p. A-10.

"EPA Proposes List and Thresholds for Chemical Accident Prevention," *Daily Environment Report*, no. 14, January 25, 1993, pp. A-3 and A-4

Gushee, David E. (Congressional Research Service, Library of Congress), "Alternative Fuels Promises and Pitfalls," Statement to National Conference of State Legislatures, 1991 Annual Meeting, Orlando, Florida, August 11, 1991.

Jones, Jeff, Gary Marfin, and Lisa Hofmann, "An Analysis of Petroleum Industry Costs Associated with Air Toxics Amendments to the Clean Air Act," Interim Final Draft, October 17, 1989.

Jones, Russell O. and Michael H. Rusin (API), "Economic Comparisons of Refueling Vapor Control Policy Options," September 1991.

Jorgenson, Dale W. and Peter J. Wilcoxen, "The Economic Impact of the Clean Air Act Amendments of 1990," *The Energy Journal*, 14 no. 1, pp. 159-182.

Krambuhl, C.J. (API) to members of API's General Committee on Refining, June 22, 1993 and July 7, 1993, and attachments.

Leonard, V. Kenneth (API) to Susan R. Wyatt (EPA), December 5, 1990, and attachment.

Montgomery, W. David and James L. Sweeney (Charles River Associates Incorporated), "Final Report: Mandates for Alternative Fuels: A Policy Analysis," for API, August 1991.

National Petroleum Refiners Association, "U.S. Refining Industry Capability to Manufacture Ultra Low Sulfur Diesel Fuels," 1986.

Perkins, Jody (API), "Revised Cost Estimates for Petroleum Industry Compliance with the Air Toxics Provisions of the Clean Air Act Amendments of 1990," September 21, 1993.

Rusin, Michael and Lisa Hofmann (API) to Bob Strieter (API), February 21, 1990 and backup analyses.

Scherr, Richard C., G. Allan Smalley Jr., and Michael E. Norman, "Clean Air Act complicates refinery planning," *Oil and Gas Journal*, 89 no. 21, May 27, 1991, pp. 68-75.

Waste

API, "Comments on Proposed Land Disposal Restrictions for Newly Listed Wastes and Contaminated Debris," Comments on Proposed Rule, EPA Docket No. F-91-CD2P-FFFFF, February 24, 1992.

_____, "Comments of the American Petroleum Institute on the Land Disposal Restrictions for Third Third Scheduled Wastes, Response to Court Decsion: Docket No. F-93-TTCA-FFFFF," March 4, 1993.

API, Health and Environmental Affairs Department, "Estimated Impact of the Change in the Toxicity Characteristic on the Petroleum Industry," July 25, 1989.

Beauchamp, Martha A. (API) to Sylvia Lowrance (EPA), February 7, 1991, and attachment.

"Congress Urged to Create New Program to Regulate Non-hazardous Industrial Waste," *Environment Reporter*, 22 no. 21, September 20, 1991, pp. 1341-1342.

"Cost Savings, State Concerns Support Exempting Soil Polluted by Leaking Tanks," *Environment Reporter*, 23 no. 43, February 19, 1993, pp. 2711-2712.

EPA, "Underground Storage Tanks Containing Petroleum -- Financial Responsibility Requirements and State Program Approval Objective," Final Rule, *Federal Register*, 53 no. 207, October 26, 1988, pp. 43322-43383.

_____, "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions," Final Rule, *Federal Register*, 55 no. 61, March 29, 1990, pp. 11798-11877.

_____, "Land Disposal Restrictions for Third Third Scheduled Wastes," Final Rule, *Federal Register*, 55 no. 106, June 1, 1990, pp. 22520-22720.

_____, "Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities," Proposed Rule, *Federal Register*, 55 no. 145, July 27, 1990, pp. 30798-30864.

_____, "Hazardous Waste Management Systems: Identification and Listing of Hazardous Waste; CERCLA Hazardous Substance Designation -- Petroleum Refinery Primary and Secondary Oil/Water/Solids Separation Sludge Listings (F037 and F038)," Final Rule, *Federal Register*, 55 no. 213, November 2, 1990, pp. 46354-46397.

_____, "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristic; Hydrocarbon Recovery Operations," Final Rule, *Federal Register*, 56 no. 63, April 2, 1991, pp. 13406-13411.

_____, "Guidelines Establishing Test Procedures for the Analysis of Pollutants; Identification and Listing of Hazardous Waste; Test Methods," Proposed Rule and Request for Comments, *Federal Register*, 56 no. 128, July 3, 1991, pp. 30519-30524.

_____, "Hazardous Waste Treatment, Storage, and Disposal Facilities; Organic Air Emission Standards for Tanks, Surface Impoundments, and Containers," Proposed Rule, *Federal Register*, 56 no. 140, July 22, 1991, pp. 33490-33579.

_____, "Land Disposal Restrictions for Newly Listed Wastes and Contaminated Debris," Proposed Rule, *Federal Register*, 57 no. 6, January 9, 1992, pp. 958-1042.

_____, "Hazardous Waste Management System; General; Identification and Listing of Hazardous Waste; Used Oil," Final Rule, *Federal Register*, 57 no. 98, May 20, 1992, pp. 21524-21534.

_____ "Hazardous Waste Management System; Identification and Listing of Hazardous Waste," Proposed Rule, Tentative Response to Chemical Manufacturers Association Petition, and Request for Comments, *Federal Register*, 57 no. 98, May 20, 1992, pp. 21450-21522.

_____, "Land Disposal Restrictions 'No Migration' Variances," Proposed Rule and Notice of Availability, *Federal Register*, 57 no. 155, August 11, 1992, pp. 35940-35954.

_____, "Land Disposal Restrictions for Newly Listed Wastes and Hazardous Debris," Final Rule, *Federal Register* 57 no. 160, August 18, 1992, pp. 37194-37282.

_____, "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Recycled Used Oil Management Standards," Final Rule, *Federal Register*, 57 no. 176, September 10, 1992, pp. 41566-41626.

_____, "Suspension of the Toxicity Characteristic Rule for Non-UST Petroleum Product-Contaminated Media and Debris," Proposed Rule, *Federal Register*, 57 no. 248, December 24, 1992, pp. 61542-61556.

_____, "Exemption of Petroleum-Contaminated Media and Debris From Underground Storage Tanks From RCRA Hazardous Waste Requirements: Proposed Rule," *Federal Register*, 58 no. 28, February 12, 1993, pp. 8504-8512.

_____, "Corrective Action Management Units and Temporary Units; Corrective Action Provisions Under Subtitle C," Final Rule, *Federal Register*, 58 no. 29, February 16, 1993, pp. 8658-8685.

_____, "Draft Regulatory Impact Analysis for the Final Rulemaking on Corrective Action for Solid Waste Management Units: Proposed Methodology for Analysis," March 1993.

_____, "Land Disposal Restrictions for Newly Identified and Listed Hazardous Wastes and Hazardous Soil," Proposed Rule, *Federal Register*, 58 no. 176, September 14, 1993, pp. 48092-48204.

"Final Rule on Corrective Action Units Removes Barrier to Bioremediation, EPA Says," *Environment Reporter*, 23 no. 43, February 19, 1993, pp. 2707-2708.

Gruy Engineering Corporation, "Estimates of RCRA Reauthorization Economic Impacts on the Petroleum Extraction Industry," for API, July 20, 1991.

Hazardous Waste Cleanup Project, "Sticker Shock: Recognizing the Full Cost of Superfund," June 1993.

"Industry Praises Corrective Action Proposal, But States, Others Say Cleanups Will be Delayed," *Environment Reporter*, 21 no. 32, December 7, 1990, pp. 1523-1524.

Jones, Russell O. and Jody M. Perkins, "RCRA Economic Impact Analysis: Refinery Nonhazardous Wastewater Surface Impoundments," API Research Study #072, September 1993.

Jones, Russell (API), "Estimated Share of Superfund Taxes Paid by the Petroleum Industry," July 12, 1993.

"SAB Economist Says Reviews of RCRA Rule, Contingent Valuation Study Should Merge," *Daily Environment Report*, no. 83, May 3, 1993, p. A-6.

Satterfield, James E., "A Tale of Sound and Fury: The Environmental Record of the 102nd Congress," *Environmental Law Reporter: News and Analysis*, XXIII no. 1, January 1993, pp. 10015-10025.

"Senate RCRA Legislation Could Cost up to $46 Billion per Year, EPA Estimates," *Environment Reporter*, 23 no. 12, July 17, 1992, pp. 888-889.

"States, Industry Favor Site-Specific Option for Regulating Contaminated Media," *Daily Environment Report*, no. 73, April 19, 1993, pp. A-2 and A-3.

"States Urge EPA to Repropose RCRA Corrective Action Rule," *Daily Environment Report*, no. 72, April 16, 1993, p. A-14.

Tischler/Kocurek, "Corrective Action Cost Study for a Generic Petroleum Refinery," for API, August 4, 1993.

Water

API, "Handling Water Discharges From Automotive Service Facilities Located at Petroleum Marketing Operations," API Recommended Practice 1633, first edition, January 1992.

Anderson, Robert and Mark Rockel, "Economic Valuation of Wetlands," API Discussion Paper #065, April 1991.

Copeland, Claudia (Congressional Research Service, Library of Congress), "Funding Water Quality Programs: Revenues for a National Clean Water Investment Corporation," July 10, 1992.

EPA, "Proposed NPDES General Permit for Coastal Waters of Texas," Notice of Draft NPDES General Permit, *Federal Register*, 55 no. 110, June 7, 1990, pp. 23378-23411.

_____, "Proposed NPDES General Permit for the Coastal Waters of Louisiana," Notice of Draft NPDES General Permit, *Federal Register*, 55 no. 110, June 7, 1990, pp. 23348-23378.

_____, "National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges," Final Rule, *Federal Register*, 55 no. 222, November 16, 1990, pp. 47990-48090.

_____, "EPA Releases Final Storm Water Discharge General Permit," press release, September 3, 1992.

_____, "Effluent Guidelines Plan," Notice of Effluent Guidelines Plan, *Federal Register*, 57 no. 174, September 8, 1992, pp. 41000-41004.

_____, "Final NPDES General Permits for Storm Water Discharges Associated with Industrial Activity," Notice of Final NPDES General Permits, *Federal Register*, 57 no. 175, September 9, 1992, pp. 41236-41342.

_____, "Final NPDES General Permits for Storm Water Discharges Associated with Industrial Activity," Notice of Final NPDES General Permits, *Federal Register*, 57 no. 187, September 25, 1992, pp. 44438-44470.

_____ "Final NPDES General Permits for Storm Water Discharges from Construction Sites," Notice of Final NPDES General Permits, *Federal Register*, 57 no. 187, September 25, 1992, pp. 44412-44435.

_____, "Final NPDES General Permit for the Western Gulf of Mexico Outer Continental Shelf," Issuance of a Final NPDES Permit, *Federal Register*, 57 no. 224, November 19, 1992, pp. 54642-54671.

_____, "Proposed NPDES General Permits for Produced Water and Produced Sand Discharges From the Oil and Gas Extraction Point Source Category To Coastal Waters in Louisiana and Texas," Notice of Draft NPDES General Permit, *Federal Register*, 57 no. 246, December 22, 1992, pp. 60926-60951.

_____, "Oil and Gas Extraction Point Source Category; Offshore Subcategory Effluent Limitations Guidelines and New Source Performance Standards," Final Rule, *Federal Register*, 58 no. 41, March 4, 1993, pp. 12454-12512.

_____, "Proposed Water Quality Guidance for the Great Lakes System," Proposed Rule, *Federal Register*, 58 no. 72, April 16, 1993, pp. 20802-21045.

_____, "Proposed Modification of the NPDES General Permit for the Western Portion of the Outer Continental Shelf (OCS) of the Gulf of Mexico (GMG290000)," Notice of Proposed NPDES General Permit Modification, *Federal Register*, 58 no. 148, August 4, 1993, pp. 41474-41480.

"EPA Orders Injection Well Closures at 1,800 Gas Stations in 49 States," *Ground Water Monitor*, 7 no. 15, July 24, 1991, p. 141

Gruy Engineering Corporation, "A Study of the Economic Impacts of Produced Water Effluent Guidelines for the United States Offshore Area," for API, November 1990.

_____, "Midcourse Evaluation Economics Study (Phases I, II, and III) Estimated Costs for Certain Proposed Revisions in the Underground Injection Control Regulations for Class II Injection Wells," June 9, 1989.

"Hill Lawmakers Want to Include Regional Provisions in Clean Water Rewrite," *Daily Environment Report*, no. 149, August 5, 1993, pp. A-5 to A-7.

Ohio Petroleum Council, "Survey of Estimated Costs of Compliance with the Great Lakes Water Quality Initiative," January 15, 1993.

ABB Environmental Services, Inc., *The OPA Liner Study*, for EPA, January 1992 draft.

Carson, Richard T., Robert C. Mitchell, W. Michael Hanemann, Raymond J. Kopp, Stanley Preser, and Paul A. Ruud, "A Contingent Valuation Study of Lost Passive Use Values Resulting From the Exxon Valdez Oil Spill," A Report to the Attorney General of the State of Alaska, November 10, 1992.

"Construction, Leak-Detection Standards for Tanks would be Set Under Senate Bill," *Daily Environment Report*, no. 34, February 23, 1993, pp. A-2 and A-3.

DOI, "Natural Resource Damage Assessments," Proposed Rule, *Federal Register*, 56 no. 82, April 29, 1991, pp. 19752-19773.

"DOI to Reopen Comments Period on Resource Damage Assessments," *Daily Environment Report*, no. 69, April 13, 1993, pp. A-1 and A-2.

EPA, "Oil Pollution Prevention; Nontransportation-related Onshore and Offshore Facilities," Proposed Rule, *Federal Register*, 56 no. 204, October 22, 1991, pp. 54612-54641.

_____, "Oil Pollution Prevention; Non-Transportation-Related Onshore Facilities," Proposed Rule, *Federal Register*, 58 no. 30, February 17, 1993, pp. 8824-8879.

"EPA Establishes Task Force to Review Rules, Meets with Congress on Legislation," *Daily Environment Report*, no. 110, June 10, 1993, p. A-11.

"Federal Judge Accepts $1 Billion Settlement, Ends Two-Year Litigation in Exxon Oil Spill," *Environment Reporter*, 22 no. 24, October 11, 1991, pp. 1533-4.

Gruy Engineering Corporation, "Assessment of the Economic Impact of Certain Anticipated SPCC Regulations Pertaining to Aboveground Storage Tanks," for API, September 1990.

Jones, Russell O., "Estimated Costs and Benefits of Retrofitting Aboveground Petroleum Industry Storage Tanks with Release Prevention Barriers," API Research Study #065, September 1992.

Marten, Bradley M. and Cestjon L. McFarland, "Litigating CERCLA Natural Resource Damage Claims," *Environment Reporter*, 22 no. 12, July 19, 1991, pp. 670-677.

Mercer Management Consulting, Inc., "The Economic Impact of Implementing the Coast Guard's Proposed Rule on Financial Responsibility," August 1992.

_____, "Interim Regulatory Impact Analysis for Vessel Response Plans," prepared for U.S. Department of Transportation, January 1993.

Minerals Management Service, DOI, "Oil Spill Financial Responsibility for Offshore Facilities Including State Submerged Lands and Pipelines," Advance Notice of Proposed Rulemaking, *Federal Register*, 58 no. 163, August 25, 1993, pp. 44797-44799.

NOAA, "Natural Resource Damage Assessments," Advance Notice of Proposed Rulemaking, *Federal Register*, 55 no. 250, December 28, 1990, pp. 53478-53479.

_____, "Natural Resource Damage Assessments," Advance Notice of Proposed Rulemaking, *Federal Register*, 57 no 50, March 13, 1992, pp. 8964-8988.

_____, "Natural Resource Damage Assessments Under the Oil Pollution Act of 1990," Advance Notice of Proposed Rulemaking, Extension of Comment Period and Release of Contingent Valuation Methodology Report, *Federal Register*, 58 no. 10, January 15, 1993, pp. 4601-4614.

"Panel Backs Use of Contingent Valuation, NOAA Says in Advance Notice of Rule-Making," *Environment Reporter*, 23 no. 39, January 22, 1993, pp. 2490-2491.

"Proposed Rule Will Increase Financial Liability for Offshore Oil Facilities," *Daily Environment Report*, no. 163, August 25, 1993, p. A-1.

Research and Special Programs Administration, DOT, "Specifications for Tank Car Tanks," Advance Notice of Proposed Rulemaking, *Federal Register*, 55 no. 94, May 15, 1990, pp. 20242-20245.

_____, "Response Plans for Onshore Oil Pipelines," Interim Final Rule with Request for Comments, *Federal Register*, 58 no. 2, January 5, 1993, pp. 244-259.

"RSPA Issues Interim Final Rule on Emergency Plans for Oil Releases," *Daily Environment Report*, no. 251, December 31, 1992, pp. A-3 and A-4.

Temple, Barker & Sloane, Inc., *Interim Regulatory Impact Analysis for the Oil Pollution Act of 1990, Titles IV and V*, for U.S. Coast Guard, October 28, 1991.

U.S. Coast Guard, DOT, "Double Hull Standards for Tank Vessels Carrying Oil," Proposed Rule, *Federal Register*, 55 no. 234, December 5, 1990, pp. 50192-50198.

_____, "Financial Responsibility for Water Pollution (Vessels)," Proposed Rule, *Federal Register*, 56 no. 187, September 26, 1991, pp. 49006-49021.

_____, "Double Hull Standards for Vessels Carrying Oil in Bulk," Interim Final Rule, *Federal Register*, 57 no. 156, August 12, 1992, pp. 36222-36246.

_____, Navigation and Vessel Inspection Circular No. 7-92, September 15, 1992.

_____, Navigation and Vessel Inspection Circular No. 8-92, Change 2, January 15, 1993.

_____, "Discharge Removal Equipment for Vessels Carrying Oil," Proposed Rule, *Federal Register*, 57 no. 189, September 29, 1992, pp. 44912-44921.

_____, "Response Plans for Marine Transportation-Related Facilities," Interim Final Rule, *Federal Register*, 58 no. 23, February 5, 1993, pp. 7330-7376.

_____, "Vessel Response Plans," Interim Final Rule, *Federal Register*, 58 no. 23, February 5, 1993, pp. 7376-7451.

_____, "Preliminary Regulatory Impact Analysis: Financial Responsibility for Water Pollution (Vessels)," July 12, 1993.

Multimedia

"Browner Announces Plan to Expand TRI To Cover More Chemicals, Industries," *Daily Environment Report*, no. 100, May 26, 1993, pp. AA-1 and AA-2.

Dames & Moore, "Evaluation of Costs and Other Impacts Imposed on the U.S. Oil and Gas Exploration and Production Industry by Implementation of Either Right-to-Know-More Legislation or SARA 313 Reporting by Regulation," for API, June 11, 1993.

EPA, "Toxic Chemical Release Reporting: Pollution Prevention Information," Proposed Rule, *Federal Register*, 56 no. 186, September 25, 1991, pp. 48475-48502.

_____ "Chemicals; Toxic Chemical Release Reporting; Community Right-To-Know; Proposed Significant New Use Rule," Proposed Rule, *Federal Register*, 57 no. 174, September 8, 1992, pp. 41020-41046.

National Petroleum Council, *The Potential for Natural Gas in the United States: Source and Supply*, vol. II, December 1992.

"Senate Water Act Reauthorization Announced; Non-point Source, Toxics Provisions Included," *Environment Reporter*, 24 no. 7, June 18, 1993, pp. 308-309.

"Toxic Release Inventory Form not Expected to Change Until 1994," *Daily Environment Report*, no. 52, March 19, 1993, pp. AA-1 and AA-2.

General/Other

API, "Petroleum Industry Environmental Performance 1992," [1992].

_____, "Environmental Expenditures of the U.S. Petroleum Industry: 1991," May 1993 draft report, forthcoming.

_____, *Basic Petroleum Data Book*, vol. XIII no. 2, May 1993.

DOC, "Current Industrial Reports: Pollution Abatement Costs and Expenditures, 1990," April 1992.

_____, "Current Industrial Reports: Pollution Abatement Costs and Expenditures, 1991," January 1993.

DOC, Environmental Economics Division, "Plant and Equipment Expenditures by Business for Pollution Abatement: Revised Estimates for 1973-83, Estimates for 1984," *Survey of Current Business*, 66 no. 2, February 1986, pp. 39-45.

EPA, *Environmental Investments: The Cost Of A Clean Environment*, Report to Congress, November 1990.

_____, "Semiannual Regulatory Agenda," *Federal Register*, 58 no. 78, April 26, 1993, pp. 24996-25090.

ICF Resources Incorporated, *Potential Cumulative Impacts of Environmental Regulatory Initiatives on U.S. Crude Oil Exploration and Development*, vol. 2: Final Report, for U.S. Department of Energy, December 1990.

"National Income and Product Accounts Tables," *Survey of Current Business*, 72 no. 7, July 1992.

National Petroleum Council, *U.S. Petroleum Refining*, forthcoming.

Perkins, Jody, "An Historical Overview of Solid Waste Management in the Petroleum Industry," API Discussion Paper #062, October 1990.

_____, "Costs to the Petroleum Industry of Major New and Future Federal Government Environnmental Requirements," API Discussion Paper #070, October 1991.

Rusin, Michael, Robert C. Anderson, and Thomas J. Lareau, "Managing the Environment: A Review of Present Programs and Their Goals and Methods," API Discussion Paper #057, February 1989.

Swain, E.J. (Bechtel Corporation) to Jody Perkins (API), September 20, 1993.

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